NATURE

Vol. 142 SATURDAY, SEPTEMBER 17, 1938 No. 3594

CONTENTS

	PAGE
The Science Museum, South Kensington	493
Kinetic Theory of Gases. By S. C.	494
Petrography of the Igneous Rocks	495
Astrophysical Methods and Problems. By A. B.	496
Radio Transmission and Solar Activity. By Prof. E. V. Appleton, F.R.S.	499
Archæological Sequence in North-West Honduras	501
Obituary Notice:	
Mr. A. J. Greenaway. By Prof. Charles S. Gibson, O.B.E., F.R.S.	503
News and Views	504
Letters to the Editor:	
The Law of Error.—Dr. Harold Jeffreys, F.R.S.	534
Effects of Be-D Radiations upon *Vicia Faba*.—Prof. Masanori Nakaidzumi and Kôiti Murati	534
Pure Stark Effect observed in Metallic Arcs.—Dr. Jiro Huruiti and Prof. Takeo Hori	535
An Application of a New Limitation in Physical Theory.—Dr. H. T. Flint	535
Ultra-Violet Band System of Silicon Monotelluride.—R. F. Barrow	536
Band Spectrum of Helium.—Dr. F. L. Arnot	536
Fundamental Physical Structure.—Rollo Appleyard	537
A Binocular Illusion.—J. D. Morton	537
Antarctica and Glacial Ages.—The Rev. W. L. S. Fleming; Prof. E. W. MacBride, F.R.S.	537
Isotopic Constitution of Potassium in Normal and Tumour Tissue.—Dr. A. Lasnitzki and Dr. A. K. Brewer	538
Active Group of Papain.—C. V. Ganapathy and B. N. Sastri	539
Excretion from Leguminous Root Nodules.—Dr. G. Bond	539
The Mexican Loggerhead Turtle in Europe.—P. E. P. Deraniyagala	540
Visual Image Produced by a Photoflash Bulb.—Ronald L. Ives	540
Research Items	541
Sixteenth International Physiological Congress. By Prof. J. H. Gaddum	543
Twelfth International Horticultural Congress	544
Institution of Gas Engineers. By H. J. H.	545
Royal Photographic Society's Annual Exhibition	546
Decapod Larvæ of the Great Barrier Reef	546
Science News a Century Ago	547
Societies and Academies	547
BRITISH ASSOCIATION DISCUSSIONS:	
Significance of the Swanscombe Skull. By W. E. Le G. C.	509
Ritual	511
The 'Middle Palæolithic'. By Miles C. Burkitt	512
Animal Locomotion	513
The Mechanism of Evolution. By D. M. S. W.	514
Post-Glacial History of the Fenland. By H. H. S.	517
Magnetic Alloys and Problems of Metallic Structure. By E. C. S.	518
Nuclear Physics	520
Low Temperature Physics. By Dr. J. F. Allen	522
Repercussions of Synthetic Organic Chemistry on Biology and Medicine	524
Physical Chemistry of Clay	526
Problems of Crop Production	527
Present Aspects of Plant Virus Research	529
Horizons in Animal Production. By Joseph Edwards	530

Editorial and Publishing Offices:

MACMILLAN & CO., LTD., ST. MARTIN'S STREET, LONDON, W.C.2.

Telephone Number: Whitehall 8831 Telegraphic Address: Phusis, Lesquare, London

The annual subscription rates are: £2 12 0 British Isles, £2 17 0 Foreign, payable in advance

Advertisements should be addressed to

T. G. Scott & Son, Ltd., 63 Ludgate Hill, London, E.C.4. Telephone Number: City 4211

Registered as a Newspaper at the General Post Office

All rights reserved

GERYK HIGH VACUUM PUMPS

ALL BRITISH

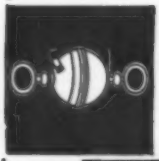
•

45 years ago we introduced the "Geryk"—the first practical mechanical high vacuum pump. Experience has enabled us to produce vacua, formerly unobtainable—e.g., ·01 millimetre off absolute vacua with single stage pumps, or up to ·00001 millimetre with the Duplex pattern.

•

2 cubic feet per minute is swept by 3-in. pump. Larger sizes up to 110 cubic feet per minute.

New pattern Geryk High Vacuum Pump



PULSOMETER ENGG. CO., LTD.
Nine Elms Ironworks, READING
39 Victoria St., LONDON, S.W.1

Write for LIST 2076

TRADE MARK **Pulsometer** TRADE MARK

CHARLES GRIFFIN & CO., LTD.

JUST PUBLISHED. Second Edition. Completely Revised.

A TREATISE ON QUANTITATIVE INORGANIC ANALYSIS

With Special Reference to Clays, Silicates, and Allied Minerals, etc.

By J. W. MELLOR, C.B.E., D.Sc., F.R.S., and H. V. THOMPSON, M.A.

CONTENTS :—Part I.—General.—Part II.—Typical Silicate Analyses : Clays.—Part III.—Analysis of Glasses, Glazes, Colours, and Complex Silicates.—Part IV.—Special Methods : Bases.—Part V.—Special Methods : Acids and Non-metals.—Name Index —Subject Index.

In medium 8vo. Cloth. Pp. i-xxxi+784.
With 2 Coloured Plates and 161 other illustrations.
Price **42s.** net. Postage **9d.**, Abroad, **1s. 3d.**

Please send for detailed Prospectus, free on application.

42 DRURY LANE, LONDON, W.C.2

Bausch and Lomb

Estab. 1853

BALOPTICANS

FOR BRILLIANT PROJECTION

are optically and mechanically dependable. Many models are offered to meet varying requirements.

LITERATURE ON REQUEST

BAUSCH & LOMB OPTICAL CO. LTD.
Africa House
KINGSWAY LONDON, W.C.2

Precision Mica Condensers

Single Units or Decades. Fully Screened.
High Insulation and Permanence.

Write for List No. 153 to :

H. TINSLEY & CO.
Werndee Hall, South Norwood, London, S.E.25
Indian Agents: Adair, Dutt & Co., Ltd., Calcutta, Bombay, Madras

Editorial & Publishing Offices:
MACMILLAN & CO., LTD.
ST. MARTIN'S STREET
LONDON, W.C.2

Telegraphic Address:
PHUSIS, LESQUARE, LONDON

Telephone Number:
WHITEHALL 8831

Vol. 142 SATURDAY, SEPTEMBER 17, 1938 No. 3594

The Science Museum, South Kensington

THE rapid extension of scientific knowledge and of its application to industry during the past fifty years, and most particularly in the post-War period, has exercised a tremendous influence on our social and economic life. We are not yet able to utilize and control this to full advantage, and therefore its source and development require to be revealed in as comprehensive and comprehensible a manner as possible to those who seek to understand. The Science Museum at South Kensington aims to provide a proper representation, commensurate with its importance, of the scientific and technical aspects of human endeavour and achievement in the national life by means of exhibits which provide a continuous story from the birth of a new idea, expressed in a new material, instrument, or machine, up to its most modern development. It differs from other national museums in that it deals with an aspect of life which is essentially dynamic and rapidly progressive, and its task necessarily becomes an increasingly complex one.

The continuous growth of scientific knowledge and the progressive reduction in the time-lag between its discovery, its application in industry, and its transformation into goods and services available to the public, present a formidable problem to those responsible for recording the process of historical evolution. This is particularly the case since many modern industrial developments have arisen not so much from an independent expansion of one branch as from the interaction of several branches of scientific knowledge, so that sectionalization in presentation is rendered increasingly difficult.

The object of the Museum is in the first place educational. It is inevitable that the community will become increasingly aware of the reaction of science on its everyday life, and a well-equipped museum is the best means of ensuring an intelligent appreciation of scientific and technical developments and of the benefits which they bestow. It is very important that the Science Museum should keep abreast of these developments, so that the average visitor may see clearly the relation to what has gone before of the devices which he is called upon to use in his normal activities. In performing this function the Museum does a very great service to the industry of the country.

In order to deal with this complex situation, the Science Museum has adopted the practice of combining with its permanent, historical and sectionalized exhibition, exhibitions of a temporary character dealing with special industrial developments of considerable present importance, from which individual exhibits may be withdrawn afterwards for incorporation in the permanent collection. The interest which these temporary exhibitions arouse may be judged from the fact that the most recent one, on Electrical Illumination, was attended by more than a quarter of a million people, while during 1937 the total number of visitors to the Museum as a whole was more than one-and-a-quarter millions. The vast majority of these are not idle sightseers but persons genuinely interested and keen to learn something from what they see, and it would be impossible to over-estimate the educational and inspirational benefit which accrues, particularly to young people, from this visual exposition of scientific and technical development.

It has become increasingly evident, however, that the space available is quite inadequate to enable the Museum to develop in a manner befitting its importance. At the present time the existing collection is badly overcrowded, and it is

not possible to house or display it with the dignity which has been given to our arts and humanities, to find accommodation for objects in store or acquirable which should rightly be exhibited, or to advance towards the creation of several new sections for which there is a pressing need.

In 1911–12 a Committee, under the chairmanship of Sir Hugh Bell, recommended the construction of new eastern and central portions and visualized their completion by 1922; the eastern portion was finally completed in 1928, but no start has yet been made on the centre portion. Even, however, if the latter were available in the form suggested by the Committee, the total space then available would permit of only a partial satisfaction of the present needs, and would, therefore, leave no provision for such natural growth as is to be expected during the next fifty years. The total exhibition space which the Advisory Council of the Museum has estimated to be necessary amounts to some fifty per cent increase over that envisaged by the Bell Committee. It is realized that this estimate is conservative, but it has been kept down to this figure deliberately in order that the collections in the Museum should not exceed what can be usefully displayed in the convenient compass of one building. The Council advocates that the main exhibition galleries should be confined to not more than three floors, a system which has been wisely adopted in both the older and the newer museums of Great Britain and other countries.

These considerations constitute the basis of recommendations which have been put before the Board of Education recently by the Advisory Council, and with the full support of the Federation of British Industries, for a considerable extension of the present space allocation in South Kensington. The present time is opportune, since the site adjacent to the existing buildings, on which any extension must necessarily occur if decentralization is to be avoided, may soon become available by the project now under consideration for the readjustment and expansion of the Government and collegiate institutions situated on the area between Kensington Gore and Cromwell Road. The calculation of the site area necessary to provide the estimated floor space required, and allowing for the inclusion of some central courts to admit light into the galleries, covers the area enclosed by the Natural History Museum boundary, Exhibition and Imperial Institute Roads, and Queen's Gate, exclusive of the two blocks occupied by private residences and the Meteorological and Post Offices. The acquisition of this site is, in the opinion of the Advisory Council, essential if practical effect is to be given to that long view of the future function and progress of the Museum which its national importance and value to the industry demand.

It is to be hoped, therefore, that the Board of Education will give the most serious consideration and its ultimate endorsement to these recommendations; the value of the Museum as a means of educating the general public and of demonstrating the continuous development of our national resources is becoming increasingly appreciated by industry, and there need be no doubt as to the enthusiasm with which industry would support, and give assistance towards, their full subsequent realization.

The example has been set in Germany by the Deutsches Museum in Munich, and in the United States by the Rosenwald Museum in Chicago; in Great Britain we need not, and should not, suffer as we now do in comparison with them.

Kinetic Theory of Gases

Kinetic Theory of Gases:
with an Introduction to Statistical Mechanics. By Prof. Earle H. Kennard. (International Series in Physics.) Pp. xiii + 483. (New York and London: McGraw-Hill Book Co., Inc., 1938.) 30*s*.

NEW books on the kinetic theory of gases are rather rare phenomena. The best early comprehensive works on the subject were written in German, by O. E. Meyer ("Kinetische Theorie der Gase", first ed. 1877) and L. Boltzmann ("Vorlesungen über Gastheorie", vol. 1, 1895; vol. 2, 1898); the former book was meant for physicists, and the latter for mathematicians. The second edition of Meyer's treatise, translated into English by R. E. Baynes, was published in 1899, and even now is worth reading. It has not been reprinted, probably because of the appearance in 1904 of the first edition of Sir James Jeans's "Dynamical Theory of Gases".

The expressed aim in Jeans's first edition was "to develop the Theory of Gases upon as exact a

mathematical basis as possible". The fact that further editions of this book were called for in 1916, 1921 and 1925 shows that the book proved widely useful and acceptable. In the second and later editions the original aim was "combined with an attempt to make as much of the book as possible intelligible to the non-mathematical reader", for which reason the plan of dividing the book to a large extent into mathematical and physical chapters, which was already partly adopted in the first edition, was more extensively followed. The later editions grew in size, but not because the developments of the classical Maxwell-Boltzmann theory, made between 1910 and 1917, were incorporated; only their results were quoted. Little was added, moreover, concerning the new experimental researches on gases; the new matter mainly referred to the quantum theory, which gave an entirely new outlook on the difficulties concerned with the equipartition of energy, discussed at length in the first edition. Much of the chapters on quantum theory, in the later editions, had but slight bearing on gas-theory.

In 1927 L. B. Loeb published the first edition of his "Kinetic Theory of Gases", which made a considerable break with the Jeans tradition. He omitted altogether most of the difficult mathematics, for which he substituted an account of many topics nearly or wholly omitted by Jeans, such as the experimental and theoretical work on the Brownian motion by Perrin and Einstein, the studies of rarefied gases by Knudsen, and a discussion of magnetism in gases.

Now again from across the Atlantic comes another "Kinetic Theory of Gases" in English, by E. H. Kennard. This resembles the book by Loeb much more than that by Jeans. The treatment is actually more mathematical than that of Loeb, but the difference between the two is small compared with the great gulf that would separate either book from one giving a systematic mathematical presentation of the pure kinetic theory of gases. Few physicists, however, will wish to penetrate far into the mathematical labyrinth of the theory of gases.

Justification for a new book on the subject, on the same general lines as were followed by Loeb, may be found in Prof. Kennard's inclusion of work, both experimental and theoretical, that has appeared since 1927. Among the additional topics, or topics treated in a materially different way, in Kennard's book, are statistical mechanics, leading up to statistical wave mechanics; the wave-mechanics of gases; and molecular beams and scattering. The author also goes further into the approximate theory of the mean free-path phenomena, and follows Jeans—somewhat distantly—in referring to terrestrial and planetary atmospheres.

If one book could be made out of the two by Loeb and Kennard, the reader's convenience might be still better met than by the possession of the two separate works. But it will certainly be worth the while of many possessors of Loeb's treatise also to read the new book by Prof. Kennard. The book is well documented, and will materially help readers wishing to follow recent work; although the kinetic theory is now, as Prof. Kennard says, in a state of "staid maturity", it retains importance in modern physics, which has many interesting interactions with it: an example is the theoretical calculation of the accommodation coefficient, duly referred to in the book under review. A novel and commendable feature is the inclusion of a number of exercises for practice.

S. C.

Petrography of the Igneous Rocks

A Descriptive Petrography of the Igneous Rocks By Prof. Albert Johannsen. Vol. 3: The Intermediate Rocks. Pp. xiv+360. Vol. 4, Part 1: The Feldspathoid Rocks. Part 2: The Peridotites and Perknites. Pp. xvii+523+1 plate. (Chicago: University of Chicago Press; London: Cambridge University Press, 1937.) 21*s*. net each.

VOLUMES 3 and 4 of this work complete what must be the most compendious handbook of petrography ever issued. In the first volume Johannsen gave an admirably illustrated account of rock textures and structures, together with an account of the many systems of classification in use. He himself has devised a quantitative mineral classification, and this is used in the descriptive part of the work. In this system rocks are first divided into classes according to the relative amounts of light- and dark-coloured minerals present, and then into families and sub-families on the percentage ratios of certain other mineral components actually present.

To some extent the divisions thus made cut across those generally used. Thus the second volume includes all the rocks with more than 5 per cent of modal quartz, and quartz-bearing varieties

of basic rocks are found in the same volume as the acid granites and rhyolites. Those with less than 5 per cent are described in the third volume under the title of "The Intermediate Rocks". They comprise syenites, monzonites, diorites, norites and gabbros together with their hypabyssal and volcanic equivalents. In the older classifications many of these are termed basic, and indeed such rocks, norites, gabbros, dolerites and basalts, occupy half the volume. Volume 4 is divided into two parts. The first part, "The Feldspathoid Rocks", includes the so-called alkali-syenites, essexites and gabbros with the corresponding lavas and intrusives. In the second part, "The Peridotites and Perknites", the ultrabasic rocks, are described.

One of the author's aims is to bring precision to the nomenclature and classification of igneous rocks. Accordingly, in his treatment of the families, the units for descriptive treatment, he first reviews the history and definition of the rock name. He is able to show that with the passage of time many rocks have been given names to which they are not entitled, and that many new names have been given to rocks that would conveniently fall into types already defined. Where ambiguity occurs he suggests a re-definition of the type, or in some cases that the name should be abandoned and another adopted. He is fertile in the invention of new names. He then proceeds with the macro- and micro-scopic characters of the rocks in the family, and in all the principal groups gives a full account of the mineralogy. Tables of chemical analyses, of norms and of modes are abundant. In the author's classification the mode is all-important, and where the original description of a rock lacks this, Johannsen has frequently supplied it from typical material. The treatment is very full and comprehensive.

Some idea of the scope of the work is given by the indexes, of which three are given at the end of the last volume. More than 800 authors are cited, some of them being referred to many times. Localities number more than 2,000, and there are more than 1,200 rock names. Though many of these have been devised by Johannsen to suit his classification, there can be few, if any, old names omitted. These are all adequately referenced, and it is pleasing to note that the author has personally verified all references to which he has access. The few that he has been unable to check are indicated.

The value of the work is independent of the classification or the nomenclature. An enormous amount of data, gathered from world-wide and often relatively inaccessible sources, is made available in one work. To petrographers it will be a mine of information and a great time-saver. It is the fruition of the life-work of a great petrographer and scholar.

The general get-up of the volumes is excellent. They are well printed on good paper, with pleasing type. Proof reading has been well done, the few corrigenda for the early volumes being mainly in the spelling of place-names. The binding is such that a volume of 500 pages will remain open at any page. The book will be a welcome addition to any geological library.

Astrophysical Methods and Problems

Astrophysik

Herausgegeben von B. Strömgren. (Handbuch der Experimentalphysik, herausgegeben von W. Wien und F. Harms, Band 26.) Pp. xv + 998. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1937.) 76 gold marks.

As the authors point out, the vital point in a presentation of astrophysics in one volume, such as offered here, is the limitation of the material dealt with. In accordance with the character of the "Handbuch der Experimentalphysik", of which it forms volume 26, in planning this volume the methodology of the observing astrophysicists has been brought to the fore. Therefore, the main emphasis is given to a very complete representation of the methods and instruments of astrospectroscopy and astrophotometry. To perform this task it was necessary, of course, also to look into the problems of theoretical astrophysics, in order to elucidate the purpose and value of the multitude of spectroscopic and photometric observations which are now available.

In emphasizing this, Prof. Strömgren points out very clearly his and his collaborators' aims. The book is intended for both the physicist and the astronomer. It furnishes the former with the latest information regarding the methods of astrophysics. The general principles of astronomical spectroscopy and photometry are the same as those used in the laboratory. But, to solve the special astrophysical problems, a number of quite independent methods of interest to the physicist have been developed, and the methods of laboratory physics have been refined.

"For the astronomer the book is intended to serve as a textbook and a handbook of practical astrophysics." This is a great promise for a one-volume work on a subject of such wide scope, not hitherto treated in one volume as a homogeneous whole. But the promise is kept, and it is difficult to avoid superlatives in referring to the work.

The introductory chapter, by J. Stobbe of the Kiel Observatory, gives in 178 pages an outline of those astronomical subjects which do not find a place elsewhere in the book. Here we have paragraphs on co-ordinates and time, on the positions and motions, and radiation of the stars, giving the essential principles. Stobbe goes on to give an exposition of the theoretical foundations of photometry and spectroscopy, adding a description of the optics and mechanics involved in the construction of astronomical instruments and observatories. An instructive chapter on the physiological and psychological components of the observer's activity concludes this clearly-written and well-condensed summary, the value of which is enhanced by ample references.

The following 139 pages cover spectral analysis so far as it is concerned with qualitative considerations. In this chapter W. Schaub first outlines briefly the problems involved in the classification of the stellar spectra, and refers to spectroscopic parallaxes, radial velocities, rotation of the stars, etc. But the position of greatest importance is occupied by an excellent description of the instruments in use, namely, the different types of spectrographs, measuring microscopes and spectrocomparators, and a full account of the methods for measuring and reducing the spectrograms. Here we find also especially useful the detailed survey of the ways of testing the optical and mechanical parts of the spectrographs, and of all the various corrections to be allowed for in practical radial velocity work.

The photometric part of the work is naturally the most extensive of all, its treatment being divided up between B. Strömgren (Copenhagen and Chicago), H. Kienle (Göttingen), and J. Hellerich (Hamburg). Strömgren's two chapters —one on the tasks and problems of astrophotometry, the other on "objective photometrical methods"—362 pages in all, form more than one third of the whole contents of the book. Not only in quantity but also in quality these chapters form the key of the whole, and unite in an article of unique construction a wealth of material hitherto scattered in countless sources.

The wide variety of problems and the limitations of astrophotometric measures are elucidated in great detail. Comprehensive sub-chapters deal with the present photometric systems and catalogues, with the results of the work on colour indexes and on other colour equivalents. A full and stimulating discussion is devoted to the problems of spectrophotometry, towards which so much of the present-day interest in astrophysics is directed. Here Strömgren shows how the continuous spectrum has recently been opened up to far-reaching quantitative investigations, and how the resulting different types of temperatures, etc., are related to each other. Then he proceeds to the measurement and reduction of line contours, and finally treats with a number of special problems such as the spectrophotometry of surfaces, of the sun, of galactic nebulæ, etc. Atmospheric extinction belongs also to Strömgren's subject, and is disposed of in a short but interesting manner, whilst a full account is given of the instruments used for the measurement of the total radiation of sun, planets, stars, such as pyrheliometers, bolometers, thermo-, photo-electric, and selenium cells.

Photographic photometry is dealt with in a masterly way by H. Kienle. The well-known ability of this author for clear, concentrated and vivid writing helps greatly to make this chapter not only a most important but also a very pleasant one. The widely scattered data on the properties and the treatment of photographic plates are to be found here critically summarized, and the reader finds references to appropriate literature. The same may be said of the discussion of all the many different types of photometers designed for measuring photographic effects. Thus Kienle's 145 pages give invaluable information to the astrophysicist in a field of ever-growing interest.

It is logical and useful that two shorter chapters, of 114 pages, have been separated from Strömgren's and Kienle's work, namely, the treatment of the methods and the results of visual photometry and of colour measurement with colorimeters, effective wave-lengths, etc. Both articles have rightly been entrusted to J. Hellerich of the Hamburg-Bergedorf Observatory, whose own successful work lies in this line, thus enabling him to give an authoritative and well-written survey.

The same remark applies indeed to the whole book. A very restricted number of well-chosen representatives in their own special fields have succeeded in avoiding the weaknesses of some similar undertakings in other branches of science, where too great a number of collaborators prevented the necessary co-ordination, thus leading to unnecessary repetitions or omissions, and to discord in style and presentation. But in the new "Astrophysik", Rosenberg's thoughtful planning and Strömgren's firm direction have created a book which will impress the reader as being a first-class standard work.

A. B.

A Manual of Psychological Experiments

By Edwin Garriques Boring, Herbert Sidney Langfeld, Harry Porter Weld, and collaborators. Pp. ix+198+3 plates. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1937.) 8*s*. 6*d*. net.

THIS is an elementary manual of psychological experiments suitable for first-year students and containing about sixty experiments, mostly new. Besides the editors, seventeen other psychologists have collaborated to produce the book. The work is designed apparently to accompany the widely used general text-book in psychology by the same authors, but it can also be used together with any good text-book.

Many of the fifty-nine experiments are planned on traditional lines; twenty-three are concerned with psychophysics and sensation, seven are on perception, eight on learning and the rest on emotion, action, thought and personality. The methodology of each experiment is given briefly and clearly together with a number of questions and a few essential references.

An advantage of the course of experiments is the simple and inexpensive apparatus that is required. A disadvantage is the absence of the more recent experiments used in researches in *Gestalt* psychology. There is only one experiment on memory and none on attention, will, imagination, perseveration, oscillation, or fatigue. It is a relief to see that the plethysmograph is not introduced as a measure of affectivity. Most of the experiments are planned to take about one hour; a few take about two hours and can be performed with large or small groups.

A short chapter is included on the computation of a few statistics, but no instruction is given in the psychophysical methods.

The manual is to be recommended for use by students in England, and could also be used to much advantage in tutorial and extension classes in psychology.

J. I. COHEN.

A Textbook of General Botany:

for Colleges and Universities. By Richard M. Holman and Prof. Wilfred W. Robbins. Fourth edition. Pp. xvii+664. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1938.) 20*s*. net.

THE subject-matter in the fourth edition of this familiar text-book has not been materially changed, though in the light of most recent research it has been brought up to date. It is a pity that the subject-matter has not been modified, for it is based essentially on the morphological concept. Physiology receives scant treatment; the chapter on evolution and heredity is wellnigh out of date and genetics is practically ignored. Research on the more practical side of botany, and especially strictly economic botany, is going on apace, especially in the country of origin of this book, yet it scarcely receives a mention.

These blemishes are unfortunate, for works by the late Prof. Holman and Prof. Robbins are well known and widely used. The book, as it is, brings that narrow conception of botanical science to the reader which was peculiar to the academic student of twenty years ago. Substantial changes are slowly taking place, and it is to be regretted that such an otherwise authoritative and well-written text gives so little attention to them.

The Farming Year

By Prof. J. A. Scott Watson. Pp. 144+64 plates. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1938.) 7*s*. 6*d*. net.

THIS excellent little book has been written at the request of the National Federation of Young Farmers' Clubs. The farmer's son may be familiar with the type of farming practised in his district, but in most cases he will not have had the opportunity of taking at first hand a general view of our very varied husbandry. The next best thing is to have the situation briefly and accurately set out by a competent observer. Prof. Scott Watson has written his account in very simple style, and continually directs the attention of his readers to the causes that have operated to mould agriculture into its present form. The main styles of farming each form the subject of a chapter, and the scope is wide enough to include vegetables and flowers, farming under glass, and fruit. An outstanding feature of the book is the quality of the numerous illustrations, which with their well-phrased captions are full of information.

Readers other than young farmers will be found for this book. For the townsman, young or otherwise, it will provide a very readable account of an industry that makes as big a demand as any on the technical skill and business ability of its members.

A Swahili Dictionary of Plant Names

By P. J. Greenway. Pp. xvi+112. (Dar es Salaam: Government Printer, 1937.) 3*s*.

MR. GREENWAY has performed a very valuable service to all interested in the life of the East African native by the preparation of this dictionary. Hitherto the available information was scattered through larger dictionaries or recorded only in botanical papers or on herbarium sheets. Now the accurate identification of the native names of medicinal, food and other plants will be greatly simplified.

Under each native name the English equivalent, if any, is given, followed by a brief description and the scientific name and family. Notes on the uses of the various species are also given, and there is a list of native morphological terms and a botanical glossary.

As Mr. Greenway remarks in his introduction, the vegetable kingdom plays a very important part in the economy of the African native. A thorough knowledge of native usage in plant nomenclature is therefore a valuable asset in understanding the African mentality, and the publication of this well-prepared and handy dictionary will be welcomed by all those concerned with study and administration in East Africa.

Radio Transmission and Solar Activity*

By Prof. E. V. Appleton, F.R.S.

I PROPOSE to review very briefly the progress made in certain branches of radio research since the last General Assembly of the International Scientific Radio Union in 1934. In selecting such topics for consideration I have been constantly struck, as many others doubtless have been, by the way in which the range of the interests of the radio worker has been gradually expanding, so that now it overlaps almost every field of physical knowledge. In that everyday tool we employ, the amplifying valve, we find problems of thermionics, electrostatics and electrodynamics. The study of aerials and their radiative properties involves problems entirely analogous to those of physical optics. The investigation of the travel of radio waves excites our interest in fundamental atomic processes by way of which the electron population in the ionosphere increases and decreases. The profound control maintained by the sun on the ionosphere and, especially, the response of upper atmospheric conditions to events on the sun's surface, identifies our interests closely with those of the solar physicist, while, by way of the troposphere, which is the seat of atmospheric disturbances, we find much of common concern with the meteorologist.

Radio researches depend fundamentally on the behaviour of the electrical circuits we employ at both sending and receiving stations. To make measurements on long waves and on low-frequency oscillations is comparatively easy, but, with ultra-high frequency oscillations, where the wave-length is comparable with the size of the apparatus, such measurements have demanded the development of a new technique of great elegance in which our Italian colleagues have played an outstanding part. The result is that, with the availability of new valves and new circuits, a rich field of research has been opened for our exploration.

The study of the travel of ultra-short waves to distances beyond the horizon has again directed attention to the classical problem of the transmission of waves around an imperfectly conducting earth. The pioneer work of G. N. Watson on this subject has been used as the starting point of more recent investigations, but, while the solution of the problem reached by him was formally complete, its application to practical cases has encountered considerable practical difficulties. Elucidations and extensions of Watson's analysis have been recently made by Eckersley, Wwedensky and van der Pol and Bremmer which readily permit the comparison of theory with experiment in practical cases where the sender and receiver are elevated above the ground. As the last two authors have shown, the theory predicts no marked diminution in the intensity of television signals on wave-lengths of the order of 7 metres when the receiver passes beyond the optical horizon of the sender. The attenuation of such signals is, in fact, determined by the finite conductivity of the earth rather than by lack of bending over moderate distances. Whether atmospheric refraction further assists the influence of the diffraction is still not quite certain, and further systematic experimental investigations on the subject are desirable.

The systematic investigation of the ionosphere by means of radio waves has been actively pursued during the last four years. The critical frequency method of measuring such upper-atmosphere ionization densities has now received widespread adoption, and the register compiled by the Ionosphere Sub-Commission shows that as many as twenty-four stations are at present making measurements of this type in different parts of the world. Observations have, for example, been made within ten degrees of the North Pole and within forty-seven degrees of the South Pole. In some cases both sender and receiver are manually operated ; in others, part or all of the apparatus is automatic and requires merely maintenance attention. But in all cases there is obtained the relation between equivalent height of reflection at vertical incidence and electric wave frequency, from the features of which the maximum electron concentrations in the various ionospheric regions may be calculated.

Observations made by the critical frequency method are now sufficiently extensive to permit us to make various deductions concerning the major ionospheric variations. There is now ample evidence to show that, during the daytime, the behaviour of Regions E and F_1 is such as can be explained by a simple theory involving the simultaneous operation of photo-ionization by solar radiation and recombination. Region F_2, on the other hand, behaves abnormally, since experiments conducted in the northern hemisphere have shown that, over a period of years, the summer noon ionization is actually less than the corresponding winter value. Valuable additional

* From the presidential address to the International Scientific Radio Union, delivered in Venice on September 4.

information on this point has more recently resulted from the comparison of results made at the two stations of Washington and Watheroo, which are situated at approximately the same distances north and south of the equator. At first it appeared that Region F_2 ionization varied similarly at both of these stations, indicating an annual effect, but a more extended series of observations showed that this was not the case. The nature of the anomaly was clearly elucidated by Goodall, who in a very important discussion of the available Washington and Watheroo data, showed that there is a seasonal variation in both hemispheres together with non-cyclic changes which appear to affect both hemispheres similarly and is related in some way to the general solar activity. It will be thus seen that there are two problems associated with Region F_2. One is to explain the anomalous seasonal effect, first recognized in the northern hemisphere, and the other is to explain the non-seasonal variation which has been found in the examination of the valuable observations in both hemispheres made by Berkner and his colleagues under the auspices of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington.

Advantage has been taken by members of the International Scientific Radio Union to make ionospheric observations on the occasion of three out of the four solar eclipses which have taken place since 1934. The results have amply confirmed the earlier conclusions that the electrons in Regions E and F_1 are liberated by solar photons and are captured according to a recombination law. On the occasion of the total eclipse in Japan in 1936, an opportunity also arose to investigate the origin of the so-called abnormal or sporadic Region E echoes which appear to be due to locally ionized clouds or strata embedded within the normal Region E. From the results obtained there is a suggestion of a partial solar photon origin, but it would perhaps be wiser to regard this more as an incentive to further work on the subject than as a definite conclusion. The extensive results for the same eclipse have, unfortunately, not solved the vexed question of the origin of Region F_2, for while some observers interpret the data as indicating ionization by photons, others argue, equally plausibly, in favour of ionization by corpuscles. There is, evidently, need for a further critical examination of the available data in the light of the known abnormal behaviour of Region F_2, as well as for the harvesting of further experimental observations. The forthcoming solar eclipse of October 1, 1940, in South Africa and South America should provide us with an excellent opportunity for the latter. The preparatory calculations concerning both optical and corpuscular eclipses in the ionosphere for this occasion have already been made by H.M. Nautical Almanac Office, Great Britain.

I now turn to a fascinating story in the history of solar physics, the first chapter of which was written many years ago. On September 1, 1859, a historic observation was made by R. C. Carrington, a British astronomer. While making, in the forenoon of that day, his customary examination of the forms and positions of spots on the sun, he was startled to note two patches of intensely bright and white light associated with a particular group. He hastily left his apparatus to call someone else to witness the phenomena with him but, on returning within sixty seconds, was, to use his own words, "mortified to find that the outburst was already much changed and enfeebled". On calling at Kew Observatory a day or two afterwards, Carrington was interested to learn that, at the very moment he had seen the solar flare, the three magnetic elements at Kew were similarly disturbed. About 17½ hours after these disturbances, there occurred one of the most violent magnetic storms ever observed. It should be here noted that the year 1859 was one of sunspot maximum.

This interesting story has acquired fresh significance in recent years as a result of the fertile collaboration of many workers on the subject of solar and terrestrial relationships. In 1930 Mögel, in an undeservedly neglected paper, analysed a series of short-wave radio observations made during the years of sunspot maximum 1927–29. In this paper he describes the occurrence of what he calls "short-disturbances" or interruptions of radio communication over circuits traversing the illuminated side of the earth. Such short disturbances were found to affect communication for periods up to an hour and were accompanied by a characteristic disturbance of the earth's magnetic field. Mögel suggested that the radio and magnetic effects were due to abnormal ionization in the lower layers of the atmosphere.

It would, of course, scarcely be permissible to deduce from the single observation of Carrington and the work of Mögel that the three phenomena, solar flare, radio fade-out and characteristic magnetic disturbance, were associated. That connexion has been satisfactorily established only as the result of the combined efforts of many observatories and radio stations. Such collaboration was prompted first by the French National Committee of the International Union which, through its chairman, M. Jouaust, directed the attention of other national committees to the reappearance of Mögel's "short-disturbances" in 1935. From that year onwards an extensive research has been conducted by numerous

organizations and individuals. At the request of Dr. J. H. Dellinger, for example, special solar observations were made at Mount Wilson Observatory at times when fade-outs were expected, to see if any visible solar effect could be associated with them, while an examination of old spectroheliograms immediately revealed the fact that a number of fade-outs already recorded had been accompanied by bright chromospheric eruptions. But perhaps the first really striking example of these interrelated phenomena occurred on April 8, 1936, when a very intense solar flare photographed at Mount Wilson was found to occur simultaneously with a widespread radio fade-out and the characteristic magnetic variation. As the solar activity has increased in recent years, many more examples of such correlations have been noticed.

To the student of the ionosphere, the temporary abnormal absorption of radio-waves during a fade-out is a phenomenon of great interest. When the disturbance is not too severe, and weak echoes can still be received, it is generally found that the height of reflection is not materially altered. The fade-out must thus be due, as Mögel suggested, to increased ionization at levels below those normally responsible for the reflection of medium and short radio waves. Such increased electron content in what was identified many years ago as Region *D* would be expected to have three effects. It would temporarily increase the conductivity of the lower ionosphere for the overhead currents which cause the daily magnetic variations, and so account for the observed magnetic disturbance. It would increase the normal Region *D* attenuation of radio waves passing through it and so explain the occurrence of the short and medium wave fade-out. At the same time, however, it would increase the reflection coefficient of Region *D* for the very long waves which are deviated by its lower boundary. Such enhanced reflection of very long waves on the occasion of a short-wave fade-out was first noted by R. Bureau in his study of the propagational characteristics of atmospherics.

There can be little doubt that the enhanced ionization in Region *D* during a solar flare is electronic in character, and that the exaggerated attenuating properties of this region as a radio transmission medium is due to the high frequency with which the electrons collide with the neutral molecules. Since the attenuating stratum is produced at a low level, the atmospheric absorption coefficient of the solar photons responsible must be relatively high. Possibly the electrons in question are liberated by photo-detachment from the negative ions which we suspect are present in large numbers during the daytime in Region *D*.

Archæological Sequence in North-West Honduras

DURING 1936 a joint archæological expedition of the Smithsonian Institution and Harvard University excavated a number of sites in the Departments of Cortes, Yoro and Santa Barbara in north-west Honduras. The expedition, which was in the nature of an archæological reconnaissance rather than a systematic exploration, had as its objective in part the extension of the exploratory work carried out by Dr. W. D. Strong in north-eastern Honduras on behalf of the Smithsonian Institution in 1933, in part, and more immediately, to carry further the work of Byron D. Gordon (1895–97) and of the late Mrs. Dorothy H. Popenoe (1928–29). Mrs. Popenoe's pioneer work at Playa de los Muertos, where Gordon also excavated, in affording valuable and much-needed evidence of the stratigraphical relations of early cultures in this region, had opened up new vistas in the study of the archæology of Honduras. This evidence it was the purpose of the expedition to test and extend.

A detailed report of the results of the excavations of 1936 is in course of preparation; but as the mass of material precludes early publication, a preliminary report has been prepared by Dr. Strong, the senior member of the expedition, and his colleagues, in which an account is given of the major results emerging from the investigation.*

The sites investigated lie in what may be termed the drainage area of the Ulua River (including the Chamelecon River, which formerly drained into it) north-eastward from Lake Yojoa. The environmental conditions of this region belong to two types. On one hand are the broad alluvial valleys of the lower Ulua and Comayagua Rivers with dense rain forests; on the other hand are the elevated mountain valleys with clear flowing streams, in which the rain forest is limited to the border of the stream or, in the Lake Yojoa area, of the lake, while raised plateaux with oak and pine afford a background.

The sites examined are distributed geographically in three groups: the Chamelecon group, of which Naco is the most extensive, the Ulua and Comayagua group, of which Playa de los Muertos

* Preliminary Report on the Smithsonian Institution-Harvard University Archæological Expedition to North-Western Honduras, 1936. By William Duncan Strong, Alfred Kidder II, and A. J. Drexel Paul, Jr. *Smithsonian Miscell. Collect.*, **97**, 1, 1938. Pp. 129 + 14 plates.

is the most important and for the early culture the type, and the Lake Yojoa group. This last includes only the northern shore of the lake, where is situated the most southerly ancient Mayan settlement. The reconnaissance thus covered the northern half of a natural transition area between the Pacific highland and the Atlantic lowland regions. At this point occurs one of the easiest passages across the central American isthmus from Tehuantepec to Panama, a factor of considerable archæological and historical importance.

Characteristically the sites are found either in the alluvium of the broad lower river valleys, or on the banks of the streams of the elevated valleys. Hence, while in the latter, mounds affording evidence of habitation sites, sometimes with burials added, are accessible to excavation, in the alluvial valleys, owing to the depth of the river silt, the investigation was most readily carried out by the examination of cultural deposits in the steep river banks exposed by the action of water.

At the time of the Spanish conquest, it would appear from early documentary and linguistic evidence, this part of Central America was occupied by Jicaque and Lenca-speaking peoples; but various Nahuatl-speaking (Aztecan) pueblos existed along what would seem to have been trade routes extending into this region from southern Mexico and the Pipil (Nahuatl) territory in Salvador. One such line of settlement crosses the Chamelecon near Naco and extends east to a short distance south of Trujillo. West of the Ulua there were groups of Mayan people, their influence also extending well into Lenca territory. The region, in fact, was a contact area, in which advanced Nahuatl and Mayan peoples impinged from the west upon less-advanced peoples to the east, whose linguistic affinities were with the south, and ultimately centred, possibly through the Chibchan stock, in northern South America. The archæological data now made available bear out this evidence of contact.

The artefacts obtained were predominantly ceramic—monochrome and polychrome painted ware. There was also a large number of pottery figurines in human and animal form, some of which are whistles, or had been attached to whistles. Artefacts of other material are, comparatively speaking, rare. Obsidian flakes are ubiquitous, but nowhere in large numbers. Knife blades, one projectile point and a few small celts were found. Stone polishers, pestles of large size, hammer-stones and broken metates, with a few beads of jade, jadeite, and other material occurred on various sites. Stone statues, much mutilated, are found in the Lake Yojoa area, where the sites are particularly rich in painted pottery and have been a prolific hunting ground for collectors. One specimen only of metal was found, a small fish-hook of copper from Las Flores Bolsa in the Ulua area. Charcoal, with hearths or fire-pits, is found on the floors of habitation sites, while burnt clay shows the impression of wattle and daub. The evidence of the numerous animal bones in the early culture of Playa de los Muertos points to a hunting people. Human skeletal remains from the numerous burials were in too bad a condition to provide much, if any, material of evidential value.

The excavations revealed a striking general resemblance in the stratification and contents of the deposits. Two distinct cultural horizons are separated by a period of sterility. The upper cultural level, marked by the occurrence of pot-sherds, begins on the stratified sites other than mounds at a depth below the surface of usually from forty to eighty centimetres, but sometimes more. It is characterized by two distinct classes of pottery, painted and a coarse domestic ware. On the painted pottery the decorative designs are either conventionalized animal or human forms, or geometric. They are of various colours, red, black, white, purple and sometimes blue on a background or slip of white, black, orange, buff or yellow. This ware is polished, some to a high degree. In some instances incised ornament also appears. On most, if not all of the sites, however, the second class or domestic ware predominates. This is normally a monochrome varying from a deep or brick red to grey or black; but a considerable number of sherds show crude linear designs in brown, deep red, or black.

The upper cultural level is superimposed on a sterile level of a sand and/or clay extending from approximately two to as much as four metres down. On certain sites a cultural horizon appears below the sterile deposits. It belongs to an earlier culture, and at Playa de los Muertos comprises from the four- to the six-metre level. The distinguishing feature of this culture is a form of pottery falling into a number of types or classes according to surface finish and decoration. The ware is found both with slip and without, and is mostly highly polished. One class, however, is a painted ware, black and red, or red and buff, and rarely a white slip with red lines. Not only is this painted pottery rare, but also it is highly variable, and has an experimental appearance. Certain finds suggest that Usulatan ware, such as is found in Salvador, "the earliest painted pottery found in Central America", forms a part of this early cultural complex. At Los Narranjos on Lake Yojoa occurs what is apparently an early form of the Playa de los Muertos early culture. It shows a very primitive type of pottery; but its chronological relations are not yet definitely established.

The main significance of these results lies not so much in the character of the finds on individual sites, as in the light thrown as a whole on the cultural sequences and affinities of north-western Honduras, and ultimately as a contribution towards the solution of the archæological problem of Central America, more especially in the matter of cultural and ethnic origins.

In determining the sequence and chronological relation of the cultures revealed by the results of this archæological reconnaissance, a point of departure is afforded by the excavations at Naco on the Chamelecon River, an important native settlement, also occupied for long by the Spaniards. Here in association with evidence of Late Nahuatl influence and a painted pottery culture were found two pieces of European pottery, of which, if one may have been a later intrusion, the other was probably contemporary with the early Spanish occupation.

From this point the cultures determined may be arranged in a chronological sequence as follows. First in the upper cultural level comes the Ulua Polychrome, comprising the domestic monochrome and two (or three) classes of painted ware, of which one, showing conventionalized human and animal forms, both from the character of the decorative motifs and the form of the vessels, is undoubtedly of Mayan derivation; and with this is the class, or classes, termed Bold Geometric and Bold Animalistic, the latter from Lake Yojoa, in which certain animal forms appear, but nevertheless to be associated closely with Bold Geometric. In both the Mayoid and the Geometric and Animalistic classes there is evidence of a lower and an upper type, indicated by a development from a more naturalistic to a more highly conventionalized style, in which animal forms found in early Geometric disappear. The Mayoid pottery occurs in such quantity as to justify the inference that it is the product not merely of Mayan influence but also of an actual association of Mayan settlers with the makers of the Geometric and Animalistic classes, each group pursuing its own tradition. The Geometric of the Ulua River is attributed to the Jicaque, the Animalistic of Lake Yojoa to the related Lenca.

As connecting links between the Ulua Polychrome and the earlier culture of the lower level of Playa de los Muertos are placed tentatively the Ulua Bichrome from Santa Rita and the early painted ware, Playa de los Muertos Bichrome, between which there would appear to be some evidence of relation. The occurrence of Usulatan ware in this level at Santa Rita is a link with Salvador, while the painted ware of Playa de los Muertos is referred to early levels at Uaxactun. The early Playa de los Muertos culture from the lower level on this site, which precedes the sterile deposits, may itself be preceded by the apparently primitive Monochrome from Lake Yojoa—a point still to be determined.

As regards the absolute chronology of this series of cultures, it is suggested, not without reason, that the Ulua Polychrome represents a development which took place after the fall of Copan, where the dated monuments, according to one computation, come to an end at A.D. 800. The Mayan element in north-western Honduras, on this argument, would represent settlements made on the dispersal which followed the fall of the Mayan Old Empire.

Obituary Notices

Mr. A. J. Greenaway

JOHN GREENAWAY, for so he was known to his numerous friends, died after a long illness at Mill Hill on August 25. He was born at Islington on July 12, 1852, the youngest of four children and only son of John Greenaway (1816–90), well-known as a wood engraver and draughtsman from whom that great artist, Kate Greenaway (1846–1901)—the greatest and closest friend among many her brother ever possessed—derived her artistic inspiration.

After his early education at a local private school, Greenaway was apprenticed to his father, but later by his own wish he was allowed to study chemistry and entered the Royal College of Chemistry in Oxford Street, and was appointed demonstrator under Sir Edward Frankland when the College was transferred to South Kensington. Among his pupils during that period (1872–81) were the late Profs. W. H. and A. G. Perkin, with whom Greenaway maintained lifelong and intimate friendships. In 1880, Greenaway became an abstractor for the Chemical Society, beginning an editorial connexion which lasted until his retirement in 1924. In 1885, he was appointed sub-editor in charge of the Abstracts, and after the death of his friend, Dr. J. C. Cain, in 1921, he became editor.

During the early part of his work for the Chemical Society, Greenaway lived with his sister, Kate, in the house at Frognal, Hampstead, which had been built for her. After her death, he went to live at The Orchard, Chertsey, which was owned by Miss Ethel Boyce, a well-known musician. Through most of his life, Greenaway knew intimately great artists and musicians, particularly friends of his sister.

Had it been possible for Greenaway to complete his chemistry training in Germany, as was then the custom, there is evidence that he might have become distinguished in his chosen profession. There is also evidence that had he not devoted his life to chemistry he might have become a distinguished artist. As it was, he was overburdened in his younger days with routine and irksome teaching from which he had to break away. In 1877, he published a paper, with the late R. J. Friswell, on thallous platinocyanide, and in 1881, while still teaching, he translated and edited, with the late Prof. W. R. Hodgkinson, Wislicenus's "Short Text-book of Organic Chemistry". At a time when he must have been fully occupied with editorial work he edited in 1891 the translation of the fifth edition of Mendeléeff's "Principles of Chemistry"; he also edited with the present writer a volume of the Faraday Lectures for the Chemical Society and he wrote a charming personal account of his friend, Prof. W. H. Perkin, who died in 1929. Greenaway became a fellow of the Chemical Society in 1874 and was elected a vice-president in 1924. He was an original fellow of the Institute of Chemistry (1877).

For the Chemical Society, John Greenaway did outstanding and self-sacrificing work, and to him the Society must always be greatly indebted. He will long be remembered for his personal charm and modesty by many whom he taught to appreciate, as he did so intensely, beautiful things.

CHARLES S. GIBSON.

WE regret to announce the following deaths:

Prof. S. Alexander, O.M., F.B.A., honorary professor of philosophy in the University of Manchester, on September 13, aged seventy-nine years.

Dr. Charles Carpenter, C.B.E., formerly president of the South Metropolitan Gas Company, on September 7, aged eighty years.

M. de La Baume Pluvinel, member of the Section of Astronomy of the Paris Academy of Sciences, known for his solar researches and for numerous instrumental developments, on July 18, aged seventy-seven years.

Sir Basil Mott, C.B., F.R.S., president in 1924 of the Institution of Civil Engineers, on September 7, aged seventy-eight years.

News and Views

Herman Boerhaave (1668-1738)

HERMAN BOERHAAVE, eminent alike as physician, chemist and botanist, was born at Voorhuit, a village near Leyden, on December 31, 1668. He first intended to become a clergyman, like his father, and after studying philosophy, theology and mathematics, qualified as a doctor of philosophy at Leyden in 1690 with a thesis on the distinction between the mind and the body. He then took up medicine, in which he qualified in 1693 with a dissertation on the importance of examining the excreta in disease. In 1702 he was appointed lecturer in the institute of medicine, his inaugural address being devoted to the importance of the study of Hippocrates. In 1709 he was made professor of botany and medicine, and five years later succeeded Bidloo in the chair of practical medicine, becoming in the same year rector of the University of Leyden. In 1718 he became professor of chemistry, on which subject he published several works, the most notable being "Elementa chemiæ" (1724), regarded by Garrison as the best work on chemistry in the eighteenth century. His other principal works are "Institutiones medicæ" (1708) and "Aphorismi de cognoscendis et curandis morbis" (1709). Moreover, in conjunction with Albinus, the greatest contemporary anatomist, he edited the collected works of Vesalius. In addition to Peter the Great, he counted among his pupils such eminent physicians as Haller, Pringle, Cullen, De Haen and van Swieten, the last of whom published a commentary on the Aphorisms. Boerhaave enjoyed a world-wide reputation, and many of his works were translated into different languages including Turkish and Chinese. His many honours included that of fellowship of the Royal Society and membership of the Academy of Sciences of France. His death took place on September 23, 1738.

Boerhaave Celebrations

THE Dutch Medical Association, the Leyden Faculty of Medicine and the Society of the History of Natural Sciences of Leyden are organizing a celebration beginning on September 23 to commemorate the two hundredth anniversary of the death of Herman Boerhaave. Visits will be paid to the old St. Cecilia Hospital, where Boerhaave gave clinical lectures, his country house "Poelgeest" near Leyden and the village of Hardewyk on the Zuyder Zee, the seat of the ancient university where Boerhaave presented his inaugural thesis on July 15, 1693. A commemoration volume will be published.

The Royal Flemish Academy of Belgium

KING LEOPOLD OF BELGIUM has recently appointed the first thirty members of the Royal Flemish Academy of Belgium. The Academy comprises three classes: Sciences, Letters (including Political and Moral Sciences) and Fine Arts. A decree creating a Flemish Academy of Medicine may be expected to follow soon. This will form a complete equivalent of the old Académie Royale de Belgique, the official language of which is French. By thus putting both Academies on the same footing, instead of merely organizing a bilingual system within the Académie

de Belgique, the Belgian authorities have achieved a further step towards cultural autonomy of the Flemish and French-speaking parts of the kingdom—following upon the creation of the Flemish University at Ghent soon after the Great War. For the present, each of the three classes of the new Flemish institution will consist of ten members appointed by royal decree. Further members will be co-opted, the total number being confined to twenty per class.

THE original members are: *Sciences:* J. De Smedt, A. Dumon, W. Robyns, G. Verriest (all of the University of Louvain); J. Gillis, J. Meuwissen, A. Schoep, H. L. Vanderlinden, A. J. J. Vandevelde (all of the University of Ghent); H. Schouteden (director of the Congo Museum); *Letters, etc.:* P. Bellefroid (University of Nymegen), E. De Bruyne, H. J. De Vleeschauwer (both of the University of Ghent), E. Van Dievoet (University of Louvain), H. de Man and R. Victor (both of the University of Brussels), J. Denucé, C. Huysmans, F. Prims and F. Van Cauwelaert (all of Antwerp); *Fine Arts:* P. Gilson, L. Mortelmans, J. Van Nuffel, composers; C. Permeke, A. Servaes, W. Vaes, painters; H. Vandevelde, architect; E. Wynants, sculptor; S. Leurs, University of Ghent; R. Maere, University of Louvain. Provisionally, Messrs. Van Cauwelaert and Schoep will act respectively as president and secretary of the Academy, the full title of which is "Koninklijke Vlaamsche Academie voor Wetenschappen, Letteren en Schoone Kunsten van Belgie".

Control of Nickel Distribution

IN a valuable paper on "The Control of War Metals as a Peace Measure", by F. E. Lathe and S. J. Cook, of the National Research Laboratories, Ottawa, the view is expressed that, although Canada produces more than 80 per cent of the world's output of nickel, control of distribution would not be a simple matter because only about 20 per cent of the annual production is used for war purposes, and the metal frequently passes through several hands before reaching the ultimate consumer. The calculations are based on 1934 figures, but the estimates are believed to be still substantially correct. The pamphlet has been forwarded to NATURE by way of comment on a suggestion made in the course of an article on "Science and a World Foundation" published in our issue of August 6, p. 227. Two further possibilities must be borne in mind. Reserves of the metal could be readily accumulated by the Government of a country which anticipated war; and, in the event of shortage, no effort would be spared to discover substitutes for essential metals. For an extended war, however, extremely large stocks would be required of such metals as iron and steel, copper, zinc and lead. The aim, therefore, should be to introduce restrictions of a temporary or unexpected character. But the only real hope of effective restriction lies in international action, and it would be most effective in the case of tin, antimony, nickel, copper and iron. This conclusion adds point to the proposal that scientific workers of all nations should, as a group, combine with other groups to give what help they can in promoting the evolution of a World State, capable when necessary of exercising suitable control over the distribution of such commodities.

Smoke-like Swarms of the Harlequin Fly

REFERRING to the letter from Mr. A. S. E. Ackermann entitled "A Curious Atmospheric Phenomenon", in NATURE of September 10, several correspondents suggest that the curious grey columns described by him were due to swarms of *Chironomus*, the Harlequin fly. Swarms of these insects dance about in the air at evening time and are commonly called "gnats", to which they have considerable resemblance, though they differ from them in being entirely harmless. They often appear in columns on a calm evening and the columns may break up and re-form with a wavy motion. Capt. C. J. P. Cave writes: "I once saw a number of such columns on a very still evening in Lombardy. At first I took them to be very small narrow pillars of smoke from burning weeds, but a closer view showed them to be swarms of gnats. The whole description given by Mr. Ackermann tallies with my recollection of the phenomenon."

National Museum of Southern Rhodesia

DR. G. ARNOLD, director of the National Museum of Southern Rhodesia, Bulawayo, writes to point out that some confusion would appear to have arisen in reference to the proposal to establish a museum for Zimbabwe, reported incorrectly to be intended as a 'National' museum (see NATURE, July 9, p. 65). The proposed museum, Dr. Arnold states, is to be a small one-roomed building, in which will be exhibited some of the original antiquities which have been found in that neighbourhood, and also plaster casts of finds which are now the property of the British Museum and of other museums in Southern Rhodesia and Cape Town. The National Museum of Southern Rhodesia, already in existence at Bulawayo, was formerly the Rhodesian Museum, which was founded in 1901 by the Rhodesia Scientific Association and the Rhodesia Chamber of Mines jointly. From 1902 the Government of Southern Rhodesia contributed to maintenance an annual grant equal in amount to the subscriptions guaranteed by the founding bodies and an annual contribution from the Bulawayo Municipality; but in 1936 the Government, acting on a recommendation made by the Museums Commission, of which Sir Henry Miers was chairman, took over the Museum under an Act of Parliament of Southern Rhodesia, and constituted it the National Museum of Southern Rhodesia. The control is vested in a Board of Trustees appointed by the Governor. It includes departments of zoology, entomology, geology, and ethnology, prehistory and national history. Under the provisions of the Act, the Board is also empowered, subject to the approval of the Governor, to acquire by agreement any existing museum in the Colony, and also, if directed by the Governor, to establish and maintain any new museum in the Colony. The number of visitors in the first year

under the Board of Trustees was 24,585, excluding natives, and in the year ending December 31, 1937, 23,501.

The Carnegie United Kingdom Trust

So all-pervasive are the Trust's activities that its annual report (Twenty-fourth Annual Report, January–December 1937, approved by the Trustees at their General Meeting held on Friday, March 4, 1938. Pp. vi+92+2 plates. Dunfermline: Carnegie United Kingdom Trust) is almost equivalent to an index to all organized voluntary effort toward social amelioration. It is noteworthy that a very large proportion of the enterprises favoured by the Trust are concerned with rural life: land settlement, rural community councils, village halls, survey of Scottish villages, local history records, schools for rural music conductors, young farmers' clubs, women's institutes, youth hostels, Y.M.C.A. farm-training scheme, village colleges, women's rural institutes' handicrafts scheme. Land settlement schemes, for which the Trust allocated £150,000 for the period 1936–40, progressed steadily last year. The Land Settlement Association now controls twenty-five estates in fifteen English counties, comprising 11,000 acres and providing, when fully developed, small-holdings for 7,000 persons, all taken from distressed areas. The settlers who are definitely established are happy in their surroundings and are mixing more and more with the old inhabitants of neighbouring villages, and the general health, especially of the children, has shown notable improvement. The Association is, however, finding it difficult to induce local authorities to make use of the powers vested in them. For many years, the Trust has fostered the development of agencies for caring for the welfare of boys and girls over fourteen years of age. Among these are the National Association of Boys' Clubs and the National Council of Girls' Clubs, which are in receipt of subsidies from the Trust amounting to £25,000 for the current quinquennium. Valuable as the work of these clubs undoubtedly is, it is very small in volume when compared with the corresponding activities in Germany and Italy.

The Agricultural Research Council

FARMERS and others interested in agriculture have sometimes expressed the view that insufficient information is available about the activities of the Agricultural Research Council. To meet what it recognizes as an important need, the Council has issued a booklet entitled "Constitution and Functions of the Agricultural Research Council", copies of which can now be obtained on written application to the Secretary at 6a, Dean's Yard, Westminster, S.W.1. The Council, which was established by Royal Charter in 1931, is responsible for tendering advice to the Ministry of Agriculture and Fisheries, the Department of Agriculture for Scotland and the Development Commissioners as to the expenditure on agricultural research of State funds amounting to more than four hundred thousand pounds yearly. It is also charged with the scientific supervision of subsidized agricultural research, and, in addition, it has research officers engaged in the investigation of particular problems. A recent development has been the acquisition of an estate at Compton in Berkshire for use as a field station. Here problems such as those involved in certain diseases of animals will be investigated on a field scale, when the necessary laboratory experiments have been carried out at the research institutes, and a supply of animals, which have been raised in isolation and are free from disease, will be kept available for the workers at these institutes. In addition to advising on research in progress, the Council plans and co-ordinates such immediate extensions of the research programme as seem necessary to secure a more intensive attack on problems of special urgency, particularly in the field of animal and plant diseases.

Nomenclature in Electrical Engineering

THE development of electrical science and its applications during the last century has led to the introduction of a host of names, units and definitions, many of them now household words. The history of these words, and of others which have been introduced, only to be discarded, is of considerable interest, and recalls the difficulties the pioneers experienced in explaining clearly new facts and phenomena. Though many terms go back to Greek science and to the sixteenth, seventeenth and eighteenth centuries, the majority belong to the last century and the days since Faraday. The subject is an intricate one and it has not, we believe, been dealt with before so fully as by Prof. G. W. O. Howe, in a paper entitled "The Concepts and Language of Electrical Engineering" read to the Association of Engineers at Calcutta, and printed in the *Engineer* of September 2. In coining the words anode, cathode, ions, electrodes and others, Faraday was assisted by Dr. Whewell of Cambridge, whose encyclopædic knowledge led someone to write, "You may roam where you will through the realm of infinity, and find nothing so great as the Master of Trinity". Whewell had proposed the terms inductricity and inducteous, which fortunately, like the mac, bob, tom and dick of Heaviside, were not adopted. Prof. Howe does justice to the various individuals who have devoted their attention to the matter of units, as well as to the committees and congresses which have assisted in standardizing them.

Indian Forest Research

THE value of forestry research work in its direct bearing upon other Government departments and industry is admirably portrayed in a publication entitled "Forest Research and Indian Industry", issued by the Government of India Press, New Delhi. Experts are maintained at the Forestry Research Institute at Dehra Dun to undertake research work in sylviculture, botany, mycology, forest protection, entomology, biochemistry, forest utilization, wood technology, timber seasoning, preservation and testing of timbers, wood-working and minor forest products including paper pulp. The work of these experts often interlocks, as becomes evident from a perusal of this very informative publication. Illustrative of some of the

sylvicultural work undertaken at the Institute is a recent paper in sylviculture entitled "Seed Weights, Plant Percents, etc., for Forest Plants in India", by J. N. Sen Gupta (Ind. Forest Records, New Series, Sylvic., 2, No. 5, Government of India Press, New Delhi, 1937). In this paper the author gives data for the date of collection, seed weight, germinative capacity and germination per cent of 505 tree species, including 52 exotics, from all parts of India. In the botany section, Mr. C. E. Parkinson published two numbers dealing with Indian tree species in the *Indian Forest Records*, New Series, Botany (Govt. of India Press, New Delhi, 1937). The first (1, No. 1) deals with the important Indian *Terminalia* of the section *Pentaptera*, comprising trees of forest and economic importance. Four species with three varieties and nine forms are recognized. No. 2 of vol. 1 is devoted to part 4 of "Illustrations of Indian Forest Plants", the paper dealing with five species of the family *Dipterocarpaceæ*.

Broadcasting Station LS-1, Buenos Aires

THE broadcasting station LS–1, belonging to the municipality of Buenos Aires and situated about 20 miles from the city, has recently been re-equipped and is now one of the most powerful in South America. The antenna is the tallest vertical broadcast radiator in South America, being 778 feet high. It uses the new shunt excitation method developed by the Bell Telephone Laboratories, a full description of which is given in their quarterly *Journal* of July. The ground system consists of 120 buried radials, each 670 feet long, with an equal additional number of radials each 280 feet in length. Power is fed on to the antenna system through a 62-ohm nitrogen gas filled, concentric copper tube transmission line, 640 feet long. The station is operated under the administration of the Colon Theatre of Buenos Aires, which is one of the world's finest opera houses, where many of the world's leading artists are heard each season. There are 16 hours of transmission daily, with a varied programme of widely international flavour and cultural and educational subjects. Its main feature is the complete transmission of the opera and other musical activities of the Colon Theatre. The Colon season was officially opened this year by the President of the Republic on May 23, and can now be heard by the great majority of the population of Argentina as well as by listeners in Chile, Uruguay and southern Brazil. A wide repertory of classic Italian, German and Russian opera has been presented in addition to a few modern Argentine works. The new studios are built below ground-level and close to the Colon Theatre and are completely sound insulated. From the broadcasters' point of view the economy and ease of operation have set up new standards. The audio-frequency response does not vary more than one decibel between 30 and 10,000 cycles. The audio-distortion is less than 5 per cent even at complete modulation. Provisions have been made for increasing the output of the 50 kilowatt transmitter to 500 kw. by the addition of a 500 kw. amplifier. The results obtained have more than equalled expectations.

The Smithsonian Institution

THE report of the secretary of the Smithsonian Institution for the year ended June 30, 1937, refers to the improvement of the National Zoological Park by the completion of three new exhibition buildings, a machine shop, a garage and new heating and electric installations. An expedition to Sumatra to obtain specimens of the interesting animals of that region for the National Zoo was still in the field, but reports indicated that it was highly successful. In the Division of Radiation and Organisms, notable advances have been made in the studies of photosynthesis, phototropism and the action of ultra-violet rays on plant growth. The Astrophysical Observatory has continued its measurements of the solar constant of radiation, and a new method has been devised in place of the 'short method' reduction of observations, used since 1923, in which a flaw was discovered. The Smithsonian radio programme, a weekly half-hour presentation of the Institution's researches and activities, continued with undiminished popularity, and accessions to the Library for the year number 11,469, mostly in exchange for the publications of the Institution. Appendixes include the report of the United States National Museum, the National Collection of Fine Arts, the Freer Gallery of Art and of the several divisions of the Institution.

Smallpox Vaccination in an Indian Epidemic

A STRIKING instance of the protection against smallpox afforded by vaccination is given in the annual report for 1936 of the All-India Institute of Hygiene and Public Health, Calcutta, recently published. During the smallpox epidemic that occurred in the first quarter of 1936, there were 604 infants and children less than five years of age on the roll of the Maternity and Child Welfare Section of the Institute. Of these children, 434 were vaccinated before or during the epidemic, and 170 were not vaccinated. Of the unvaccinated, 42 developed the disease, a case incidence of 24·7 per cent, of whom 17 died, a mortality of 10 per cent for the group, or of 38·5 per cent of the cases. In the vaccinated group, 10 developed the disease in less than a week after vaccination and before protection had developed, of whom 7 died. Excluding these cases, of the remaining 424 vaccinated efficiently, only 3 contracted the disease and all recovered, an incidence of 0·7 per cent with mortality *nil*.

Gastro-Enteritis Conveyed by Raw Milk

AN outbreak of food-poisoning occurred at Wilton, in Wiltshire, in October 1936 and was limited to consumers—chiefly children—of a particular supply of bottled raw milk ("A Report on an Outbreak of Food Poisoning due to Salmonella, Type 'Dublin' and Conveyed by Raw Milk". By E. T. Conybeare and L. H. D. Thornton. Reps. on Pub. Health and Med. Subjects, No. 82. Ministry of Health, 1938. H.M. Stationery Office. 2*d*. net). The attack of illness commenced in 12–24 hours after consumption of the milk, the chief symptoms being headache, nausea and vomiting, and later diarrhœa, persisting for 1–3 days,

and though the attacks were severe, there were no deaths. As the outbreak was not recognized for some days, bacteriological examination of the patients proved negative. However, from a specimen of the milk delivered on October 29, a *Salmonella* food-poisoning organism was isolated, afterwards identified as being a 'Dublin' type, and four days later, the same organisms was again isolated from milk supplied by the same producer. Confirmatory evidence was obtained by serological tests of the blood of nine convalescents, whose blood showed specific agglutination for type 'Dublin' in high dilution. Examination by agglutination tests of the herd of 51 cows supplying the milk picked out three cows with a high agglutination for the 'Dublin' type. Specimens of milk and dung from these three cows were examined. The milk from all three, and the dung from two, were negative, but from the dung of the third animal a heavy growth of *Salmonella*, 'Dublin' type, was obtained, and this 'carrier' cow was removed from the herd, and no further trouble ensued. It is remarked that no amount of care in milking and distribution of such a raw milk could prevent it from being a danger to the consumer.

Insulators

A SEVEN-PAGE article on "Recent Developments in Electrical Insulating Materials" by Dr. L. Hartshorn (*J. Sci. Inst.*, July) will prove of great use to constructors of electrical apparatus and will serve as a base from which research on the properties of insulating materials advocated by the Radio Research Board may operate. The author describes the properties of ebonite, of 'loaded' ebonites, of synthetic resins which can be readily moulded or used to bond laminated material into insulating boards, and when of the hydrocarbon type have dielectric constants little more than 2 and power factors so low as 2×10^{-4}. Ceramics provide insulators of the steatite group depending mainly on magnesium silicate, and of the rutile group, principally titanium dioxide, used in the construction of condensers. After shaping, both are fired and cannot afterwards be worked without difficulty. They are apt to absorb moisture which alters their properties. Certain waxes, for example, the chloronaphthalenes, have high dielectric constants and fairly low power factors. A table of dielectric constants, power factors, resistivities, mechanical and electrical strengths and softening temperatures for nearly thirty insulators is given.

Photography in X-Ray Departments

THE brochure on "X-Ray Materials and Accessories", published by Messrs. Kodak, Ltd., might well contain the word 'photographic' did not the name of Kodak at once conjure up the word; its forty pages are devoted to a description of photographic supplies for medical and dental X-ray work. Routine work demands rigid control of variables for its quick effectiveness, and this firm has realized that, provided the actual exposures are reasonably correct, the development of X-ray films can be standardized by the use of reliable reagents, proper timing and regulation of the working temperatures. In the planning of X-ray departments, insufficient attention is sometimes given to the developing and printing rooms, where laborious hours are spent in semi-darkness. Efficient planning should reduce these hours to a minimum, and the experience of Messrs. Kodak is at the service of those planning and being responsible for the photographic work in X-ray departments.

Handbook of International Organizations

AN English edition of the Handbook of International Organizations has now been issued by the Secretariat of the League of Nations. This volume of nearly 500 pages gives the particulars of nearly 760 international organizations, including addresses, names of officers, notes on finance, objects and activities. International bureaux under the direction of the League, official central bureaux and private associations and federations in so far as they have international objects and are not run for profit are included. These organizations are classified in the following groups to facilitate reference: politics and international relations; religion; arts and sciences; education; students and university organizations; medicine and hygiene; law and administration; press; feminism; labour and professions; agriculture; economics and finance; trade and industry; communications and transit; sport and touring; and miscellaneous. The utility of the volume is increased by the provision of a subject index, an alphabetical index and a geographical index. The latter indicates that 183 of the organizations have their seats in France and 140 in Switzerland, Great Britain coming next with 78 organizations and Belgium being fourth with 77.

Recent Earthquakes

THE violent earth tremors which were experienced on Monday, September 5, over a considerable area about fifty miles south of Algiers (*The Times*, Sept. 7) cannot be said to have affected an area where earthquakes of destructive intensity are usual. Small tremors are, however, quite common, especially where the land shelves steeply to the ocean deeps. Between 1911 and 1931, Mme. A. Hée listed 586 tremors, distributed in twenty-two different zones, only four of which reached destructive intensity. The observatory of Alger-Bouzaréah is actively engaged in recording and studying these local earthquakes, and we anticipate more information at a later date. An earth tremor shook Colombo, in Ceylon, early on Sunday, September 11, but no damage is reported (*The Times*, Sept. 12). In this zone severe earthquakes are practically unknown. Slight earthquakes are common along a line through Madras passing south-south-west near the southern edge of the Deccan of India, and these are often in sympathy with larger ones occurring in northern India, a fact which may be attributable to the strained condition of the peninsula. The Ceylon tremor was most probably a local surface shock due to slipping along a fault. Another strong shock was recorded by the Stuttgart Seismological Station on Sept. 7 d. 4 h. 15 m.

(*Continued on p. 533*)

NATURE

SUPPLEMENT

Vol. 142 SATURDAY, SEPTEMBER 17, 1938 No. 3594

BRITISH ASSOCIATION DISCUSSIONS

Significance of the Swanscombe Skull

THE repertoire of the human palæontologist has recently been augmented by the discovery of portions of a fossil skull at Swanscombe, in Kent. The importance of this find was given recognition by allotting a morning session of Section H (Anthropology) for its discussion.

The Swanscombe 'skull' actually consists of two bones only, the occipital and left parietal, both of which are extremely well preserved. Their interest is related to the fact that they were found in interglacial deposits containing a Middle Acheulean industry, and that their antiquity is about as well attested by geological and archæological evidence as that of any human fossil is ever likely to be. To Mr. A. T. Marston belongs the honour of having discovered the two bones of the Swanscombe skull. He came upon them at separate times, in June 1935 and March 1936, 24 ft. below the surface in the well stratified gravels of the Barnfield Pit at Swanscombe. The parietal bone was actually found by Mr. Marston *in situ*. Although separated by a distance of 8 yards, the bones are practically unworn, and articulate perfectly with each other. Moreover, they show the same state of preservation as the fossil mammal bones with which they were associated.

The deposits at Barnfield Pit are the Middle Gravels belonging to the 100-ft. terrace of the Thames; they are later in date than the Great Chalky Boulder Clay, and they are definitely interglacial deposits. Prof. W. B. R. King is of opinion that they were laid down between the Great Eastern glaciation of East Anglia and the cold period represented by the main Combe Rock of the Thames valley. This conclusion is borne out by Hinton's study of the associated fauna. *Elephas antiquus*, *Rhinoceros megarhinus*, *Rhinoceros hemitoechus* and *Dama clactoniana* bear witness to an interglacial facies. There were also found associated with the human skull bones remains of *Cervus elaphus*, *Bos primigenius* and *Equus caballus*.

The archæological associations of the Swanscombe skull have been studied by C. F. C. Hawkes. The flint implements from both upper and lower levels of the Middle Gravels (including the channel in which the skull bones were found) belong without doubt to the Early Middle Acheulean hand-axe industry (Acheulean III of Breuil). The complete absence of any sign of a distinct Levallois industry makes it impossible to allocate these implements to a later Acheulean phase. It is interesting to note that, in the Somme valley, deposits containing a Middle Acheulean industry are commonly assigned to so early a date as the Mindel-Riss interglacial period, and this corresponds to Zeuner's interpretation, on geological grounds, of the Barnfield Pit deposits.

It is unfortunate that while the geological, archæological and faunal evidence related to the Swanscombe find is so complete, the skull itself is very incomplete. Clearly it would be unbecoming for an anatomist to attempt to draw any far-reaching conclusions, in regard to the skull as a whole, from the study of an occipital and one parietal bone. Since the sutures remain still unobliterated, the bones evidently are those of quite a young individual. The age of the latter is estimated to have been twenty to twenty-five years. Since, also, the muscular impressions are rather poorly marked in relation to the size and thickness of the skull, the sex of the individual is judged to have been more probably female than male. First inspection reveals at once that—apart from their unusual thickness—the bones are quite closely comparable with those of a modern human skull. The probable cranial capacity—as inferred

by comparative studies of recent human skulls whose parietal and occipital bones show similar dimensions and curvatures—has been estimated by Morant to be 1,325 c.c. This figure, of course, is conjectural, but it remains certain that the cranial capacity of the Swanscombe skull was well within the range of variation of modern man.

Since the two bones articulate perfectly with each other, the various dimensions and indexes of the back part of the skull can be compared accurately with those of recent skulls. The result of such a study leads to the interesting conclusion that the Swanscombe skull is astonishingly similar in all its main metrical features to the average of available series of modern skulls. The height of the skull (basi-bregmatic) and the maximum bi-parietal width are, indeed, rather greater than the corresponding measurements of female British skulls. The inclination of the plane of the foramen magnum shows nothing exceptional. The occipital bone is rather unusually broad, but even this character falls within the range of variation of recent British skulls.

A minute study of the morphological features of the Swanscombe bones shows only two characters which may be considered of unusual significance. These are the general thickness of the bones, and the extension backwards of the sphenoidal air sinuses into the basi-occipital. This latter feature certainly does occur occasionally in modern human skulls, but it must at least be very rare for it to be found in a skull so young as the Swanscombe fossil. Possibly it indicates a rather strong development of the accessory nasal air-sinus system as a whole, which may have been associated with a fairly massive development of the facial region of the skull. The thickness of the bones, although it can be readily matched at some points in recent skulls, appears to be exceptional in certain regions such as the cerebellar fossa of the occipital bone and the antero-inferior angle of the parietal. In this character, the Swanscombe fossil shows an interesting resemblance to the Piltdown skull. Indeed, Sir Arthur Keith believes that the two are very closely related morphologically. However, since the remains of both are so fragmentary, this cannot be confirmed or refuted.

Lastly, the endocranial cast of the Swanscombe bones calls for consideration. This shows clearly that the brain was quite richly convoluted, and it provides no certain evidence that the convolutional pattern was any more primitive than that of modern human brains. Reference should perhaps be made to a curved furrow in the right occipital region of the cast which might be interpreted as a lunate (or simian) sulcus of a very primitive type. Apart, however, from the general difficulty of identifying sulcal impressions on endocranial casts of human skulls, this furrow (if indeed it does represent a sulcus at all) may equally well be interpreted as what the late Sir Grafton Elliot Smith termed a 'pseudo-lunate' sulcus, that is, a sulcus sometimes found in the occipital lobe of modern human brains which merely simulates a sulcus of the simian type. The endocranial cast shows localized expansions over the parietal and temporal lobes which have been described in casts of certain other fossil human skulls, and which have been regarded by some authorities as having a special significance in the later stages of the evolution of the human brain. However, similar localized eminences are sometimes to be seen on endocranial casts of modern human skulls; hence little importance can be attached to them. There is, indeed, little doubt that the endocranial cast of the Swanscombe skull would quite well pass for that of a modern skull. It indicates clearly that the brain of Middle Acheulean man had already acquired a morphological status comparable with that of modern man, a conclusion which is somewhat remarkable in view of the fact that he is commonly presumed, on geological evidence, to have lived during the Mindel-Riss interglacial period, the antiquity of which, according to Zeuner's geochronological data, must be reckoned at about 250,000 years.

It is necessary to emphasize that we have no sure evidence regarding the construction of the front part of the skull in the Swanscombe fossil. The frontal region and the face and jaws *may* have shown unusual features which would quite definitely separate Swanscombe man from *Homo sapiens*. On the other hand, it is reasonable to suppose that if these features had been of an extreme type, they would certainly be reflected in the anatomy of the occipital and parietal bones. Morant has shown that *Homo neanderthalensis* can be distinguished from *Homo sapiens* by the metrical characters of the parietal and occipital bones alone. This, however, is not the case with the Swanscombe bones.

In summary, it may be stated that, *on the evidence of the fragments available*, the remains of the Swanscombe skull suggest that Acheulean man was not distinguishable on morphological grounds from *Homo sapiens*. This conclusion is by no means at variance with the implications of recent discoveries of fossil man such as the Ehringsdorf skull, the Steinheim skull, and the Mt. Carmel skeletons, for these have already provided evidence that there existed in Europe in pre-Mousterian times a type of mankind approximating much more closely to *Homo sapiens* than the Neanderthal type which is characteristically associated with the later Mousterian culture.

W. E. Le G. C.

Ritual

IN the symposium on ritual held by Section H (Anthropology) at Cambridge on August 23, several points of interest emerged. All the speakers agreed in rejecting the shallow view, mentioned, only to refute it, by Mr. A. M. Hocart, that ritual is primarily a matter of the emotions. On the contrary, it is likely to be disorganized and made degenerate by the presence of too much emotion, although the utter absence of such a motive force may render it, like every other human activity, a dead and mechanical thing no longer of significance.

Instance after instance may be given, and was indeed given, especially by Mr. Hocart in the first contribution to the discussion, of ritual being built up and elaborated by the cool, it might almost be said the scientifically logical, working of relatively enlightened minds, those of the noble or, more especially, the priestly, class of a race on its way to civilization, for, as Mrs. Chadwick rightly insisted in her address, one of the most fruitful supplies of material is the rites of barbarous peoples, whose ceremonial is not written down, and so is, perhaps, less likely to become a fossil. When an emotional wave sweeps up from the lower and less enlightened strata of the people, the dignified structure which has been erected is all too likely to be disintegrated and even to degenerate into the merest grunts and howls, the beast-like expressions of primary emotions, fear or what not. Yet at the same time it should be remembered (a point incidentally made by Prof. H. J. Rose) that some of the highest manifestations of the religious life whereof we have any record, transcend ritual expression by as much as these outbursts of primitivism fall below it.

Once ritual has started, from whatever source, its contents and immediate intention may vary considerably. It may have for its sole or its principal object the setting forth of some piece of traditional lore, perhaps (again the point was Mrs. Chadwick's) the whole or the principal learning of the people to whom it belongs. There is such a thing as instructing a barbarous folk by means of a religious ceremony with a complicated rite. In New Zealand, for example, in parts of Polynesia, among one or two peoples of Africa, the priests are genuinely the educators of their flock, the scholars and teachers of the nation, and their rites have apparently for at least one of their objects the production of a suitable emotional state among the hearers preparatory to impressing on their minds the doctrines which it is thought important that they should know. It is not necessary that what the average European would consider religious instruction should then follow; there are rites, including chants or other literary forms, which have a not inconsiderable historical content, though not everyone perhaps would be so optimistic as Mrs. Chadwick as to the amount of the history of illiterate peoples which we can now recover from these products of their literary and religious authorities.

A characteristic and important form of ritual is that which has for its contents a myth. This was the subject of Prof. S. H. Hooke's address, wherein he dealt cautiously with some highly controversial points. There are, of course, myths which are purely etiological, existing for no other purpose than to explain why such and such a piece of ritual is gone through. They are generally pure speculation, and have nothing to do with the real origin and purport of the rite. But there are others (Prof. Hooke instanced the stories of Ishtar and Tammuz, of the Creation and of the Deluge) which are veritably the content of ritual, it existing to set them forth, not they to explain it. The line is often vague and hard to draw, but it is there and can be perceived if the examiner is expert enough.

Prof. Rose dealt mostly with magic as a content of certain forms of ritual. He used the word in Frazer's sense, without accepting Frazer's theories of its relation in time to religion. There are actions of man intended to have a direct effect upon something in his environment (especially something quite outside his real control, such as the weather), without invoking the active or passive concurrence of any power superior to man or different from him. Ritual (an example from ancient Rome was given—the ceremonial of the Lupercalia) may consist of such actions arranged, like all rites, in a pattern or complex, intended and supposed to be more effectual than a single action of the kind would be. Unlike those ritualists who dramatically set forth the doings of gods or heroes (although there is little doubt that such actions as theirs may also be magical, the re-doing of some mythical deed which was powerful of old, in hopes that it may be efficacious to-day), operators like the Roman Luperci were doing things meant to be as practical and perhaps as little mystic as the actions of the most commonplace workman who digs a drain that water may run away, or builds a fence that beasts may be kept out. They made themselves temporarily into goats in order to put the desirable lustihood of the goat into their little Palatine community, and at the same time to

scare away the undesirable qualities of the wolf, the really formidable and reputedly uncanny enemy of their flocks and herds, to say nothing of their children.

Summing up all that was said, it seems to be fairly well made out that ritual is a complex phenomenon not to be explained away by any over-simple formula, psychological or other, and that its purpose, once it is established, and indeed in its establishment, may vary within very considerable limits. That its various kinds may interact upon each other, and any given ritual may have been produced by cool priestly reasoning modified by the enthusiasms of the laity, be originally magical in its intent, strengthened to that end by the addition of a venerable myth, and finally misunderstood as being somehow pleasing to a god who had perhaps nothing whatever to do with it at first, is a proposition which none of the speakers tried to controvert, though more than one showed that he was ready, if need be, to subscribe to it.

The 'Middle Palæolithic'

IN the course of the recent meeting of the British Association at Cambridge, Section H (Anthropology) held a symposium on the "Middle Palæolithic". While it cannot be said that the question was completely dismissed in one afternoon, certain important points were dealt with.

The expression 'Middle Palæolithic' has itself become ambiguous and is no longer used by the majority of prehistorians. At the same time it appears in some of the older literature and its retention has now and again led to unfortunate misunderstandings. Originally it was somewhat loosely used to denote those western European cultures which follow immediately after the Micoquian and precede the Aurignacian. These cultures are more properly described as the later phases of the Levalloisian—Levallois V, VI, VII—and the true Mousterian—that is to say, the culture of the La Chapelle aux Saints variety of Neanderthal man. But, clearly, used thus the term 'Middle Palæolithic' was not, properly speaking, an expression of time like Middle Pleistocene, and it was obviously unsatisfactory arbitrarily to cut across an evolving culture like the Levalloisian. The content of the phrase has therefore grown to include all the cultures, before the Aurignacian, the industries of which were for the most part made from flakes, as is the case with the Mousterian and Levalloisian, in contradistinction to the *coup-de-poing*, core-tool culture or cultures.

These flake-tool industries are not all similar; they seem to have been the products of allied though slightly differing cultures. Even in Europe alone there are not a few, and to them distinct names have been given: Cromerian, Clactonian, Levalloisian, Tayacian, Weimar, Mousterian, etc. Their distribution was sometimes fairly wide, sometimes very restricted; each of them had a beginning, evolved, and came to an end; their period of existence was sometimes long, sometimes short; all were not contemporary, but many of them overlapped in time. Some of them were in part contemporary with the wholly different *coup-de-poing* culture or cultures, but distribution maps show that these two great culture groups, civilizations or culture cycles* are quite distinct, though a line of contact occurs between them in north-eastern France and Belgium and in south-eastern England. Speaking generally, one can say that the cultures comprising the flake-tool civilization are found from the North Sea to China, and those of the core-tool civilization in Western Europe only and southwards over most of Africa. It would seem that we are thus faced with the fact that as early as a period preceding the Upper Palæolithic, and in fact forming the Lower Palæolithic, there existed in the world at least two quite distinct civilizations or culture cycles each made up of a greater or smaller number of differing though allied cultures. The question of nomenclature is therefore of the greatest importance.

Our orthodox terminology is based on that propounded during the last century by Gabriel de Mortillet when describing the sequence of cultures found in France. From the foregoing it would seem now to be quite erroneous to name a culture of the flake-tool civilization found outside France by the French name—unless for some reason it appeared probable that the two cultures concerned were not merely allied but identical. The term 'Mousterian', for example, should on these grounds be restricted to the French culture the industries of which are so well known and are, incidentally, the products of a particular branch of Neanderthal man. It simply confuses the issue to use the name to describe allied industries found elsewhere in Europe, the product of differing though related cultures, simply because both belong to the same culture

* I retain the term 'civilization' because it has been used in previous publications, but I am inclined to agree with the opinion expressed to me some time ago by Prof. Gordon Childe that the term 'culture cycle', which has no popular connotation, would be more satisfactory.

cycle. Still worse is it to use this term (or perhaps equally such terms as Clactonian, etc.) to describe industries found in such far-flung parts of the world as South Africa—where, perhaps, the very excellent work of Mr. A. L. Armstrong in S. Rhodesia provides a case in point—or India. In the same way, the term Moravian should be applied to the culture belonging to the Upper Palæolithic civilization in Moravia which, though more or less contemporary with the Magdalenian of France and clearly related to it, yet differs from it in many essential ways.

Sir Arthur Keith has come to an interestingly similar conclusion from the point of view of the physical anthropologist. For the period under review he recognizes in Europe a general type, *Homo neanderthalensis*. But in various parts of the Continent he distinguishes various modifications: the Chapellian, Ehringsdorfian, Krapinian, while outside Europe he equally distinguishes a Palestinian. The number of these modifications may well be increased as knowledge increases, and will, indeed, probably be found to coincide with the different cultures of the civilization. But all the time it can be said that the civilization or culture cycle as a whole is the product of an undifferentiated *Homo neanderthalensis*.

In actual practice, a nomenclature may take the form of terms denoting (*a*) time, such as early, middle or late Pleistocene, (*b*) typology and technology, which are generally descriptive terms like 'blade and burin', 'core', 'flake', etc., and (*c*) culture, which are generally place-names like Mousterian, Acheulean, etc. The wrong use by prehistorians of culture names to describe techniques or time spans is in almost every case to be deplored. In this connexion we are grateful to Miss Garrod for a good example of the dangers of determining culture or age solely from typological and technological considerations. The flake-tool industries from Ehringsdorf and also from Taubach which she has recently been studying are on geological and faunal grounds definitely earlier in date than the true Mousterian, yet, she points out, they do resemble very closely the later industries of that culture in France.

Flake-tool industries occur profusely in East Anglian gravels, and certain gravels of the Lower Thames area have also yielded thousands of specimens. The problem of their exact horizon and date is one for the quaternary geologist, towards the solution of which such investigators as Messrs. King, Oakley, Zeuner and Paterson are strenuously working—but a lack of clarity in the archæologist's nomenclature will here only make confusion worse confounded!

MILES C. BURKITT.

Animal Locomotion

A SERIES of papers read at a symposium in Section D (Zoology) of the British Association at Cambridge on August 23 brought into prominence the recent progress which has been made in the study of animal locomotion. The movement of a fish, an insect, or a bird present problems in kinematics which are closely related to those of a torpedo or aeroplane, and it is therefore not surprising that they have been or are being solved by methods more familiar to engineers than to zoologists.

From observations of the behaviour, in a wind tunnel, of a carefully prepared model, Dr. J. E. Harris has been able to express the functions of the paired and unpaired fins of a dogfish in terms which give a relatively precise hydrodynamical picture of the whole system. He has shown, also, that the well-known transition from an asymmetrical heterocercal tail, to one in which the dorsal and ventral flukes are equally developed, can be correlated with the development of a swim bladder and with a change in the function of the pectoral fins. The latter structures are essentially 'elevating' planes in the dogfish, whereas in many teleosts they have become modified into a very efficient 'braking' system for a fish carrying out a rectilinear glide. There seems little doubt that the changes in position and size of the various fins, which have occurred during evolution, are to be correlated with the operation of comparatively simple hydrodynamical principles.

A very successful application of aeronautical principles to animal flight has recently been made by Dr. F. S. J. Hollick. By a variety of ingenious methods he has been able to demonstrate the precise movements executed by the wings of a fly during active unrestricted flight. The use of an extremely delicate system of balances has made it possible to demonstrate the direction, magnitude and point of action of the forces acting on the body of the fly when its wings are in motion. A combination of these data with those made on the reflex effect of a moving optical image has enabled Dr. Hollick to give a convincing picture of the manner in which a fly, on approaching the ceiling of a room, is able to change its direction of motion through 180° in a vertical plane, and so attach its feet to the ceiling. It is to be hoped that the

publication of these interesting and important experiments will not be unduly delayed. It would be of great interest to extend this work to a study of bird flight, particularly in view of Mr. Horton-Smith's recent observations on the flight of gulls.

It may, perhaps, be claimed that the main problems of soaring flight of birds are approaching solution, although definite observations concerning the function of the bastard wing and other anti-stalling devices are as yet few in number. The study of 'flapping' flight presents much greater difficulties. Mr. Horton-Smith's photographs, obtained by high-speed cinematography, show clearly the detailed movements of the wings of gulls during both phases of their beat, and open up the possibility of applying aeronautical methods of analysis with hope of success. There can be little doubt that a careful investigation of the properties of various types of wings when exposed to air currents of known strength and direction would yield valuable results. It is of interest to note that a suitable wind tunnel has recently been built in the Zoological Department at Cambridge by Mr. R. Brown, whose work, together with that of Mr. Horton-Smith, will be followed with interest.

To the biologist, a solution of the mechanical problems of animal locomotion is a prelude to a study of the physiological principles which control the co-ordination of the locomotory muscles. The discussion at Cambridge largely centred on an assessment of the role of environmental stimuli in the maintenance of a locomotory rhythm. The evidence presented by Prof. J. Gray and Dr. H. W. Lissmann shows that in many, if not in all, terrestrial invertebrates the maintenance of an ambulatory rhythm is dependent upon a background of tactile stimulation from the substratum. In the absence of such stimulation, the ambulatory rhythm either ceases or gives place to a swimming rhythm of totally different nature to itself. In a few instances, notably the nemertine *Cerebratulus*, one region of the body may exhibit a typically terrestrial pattern of movement whereas another, if submerged in water, may execute a swimming rhythm of different nature and frequency. The role of environmental stimuli as pace-makers for the various phases of an ambulatory cycle is clearly defined in many invertebrates, and in forms such as the myriapods, the phase difference between adjacent limbs is determined by environmental factors. At the same time, the persistence of an ambulatory rhythm in the desensitized limbs of vertebrates (first observed by Sherrington and by Graham Brown) demonstrates that in vertebrates, in any event, all environmental stimuli probably operate on bilaterally arranged centres in the spinal cord, which are capable of displaying a rhythm so long as both sides are receiving an approximately equal intensity of stimulation, whether the source of this stimulation be central or peripheral. Under natural conditions, the locomotory centres are probably responding to stimuli from both these sources: when the animal is walking, the peripheral stimuli are dominant both in intensity and in qualitative effect; when the animal is swimming, the central stimuli are probably of primary importance.

So far as is known, no invertebrate central nervous system can display a locomotory rhythm after complete isolation from the periphery, but experiments with the common leech (*Hirudo medicinalis*) show that the whole nerve cord can exhibit a co-ordinated electrical rhythm so long as a limited number of ganglia at one end of the animal retain their connexions with active musculature.

The Mechanism of Evolution

THE discussion on the mechanism of evolution, which occupied Sections K (Botany) and D (Zoology), meeting together, for the whole of August 19 at Cambridge, was an important event.

Taken together with a discussion on "Natural Selection" held by the Royal Society about a year ago, and one on the "Irreversibility of Evolution" at the Christmas meeting of the Society of Experimental Biology, it marks the end of that long period during which biologists in general had lost interest in the subject, because it seemed incapable of investigation by quantitative or experimental methods. This great change has been brought about by the recent developments in genetics and in nuclear cytology.

The discussion included certain contributions which stated some of the conditions which have resulted from organic evolution in such a manner that they could be discussed. Dr. J. S. Huxley spoke on "Character Gradients", showing that in many cases, especially among birds, but also in mammals, insects and plants, characters are found to vary regularly in a definite way with distance from a selected starting point. Thus the length of the wing in migratory birds tends to become greater in collections made farther and farther north. The change is small but significant, about

1 per cent for 1° or 2° C. of mean temperature. For such regular character gradients Huxley has coined the term 'cline' (see NATURE of July 30, p. 219). He suggested that such clines have in general an adaptive significance, and that the usually recognized geographical races merely represent special abstractions from them.

Prof. A. E. Trueman gave an admirable account of the views held by the majority of palæontologists as to the course of evolution. It is commonly observed in fossil materials that evolutionary change, whether it be in minor matters or in fundamental structures, often proceeds in a definite direction common to many allied stocks, and that in consequence similar forms (homœomorphs), which need not be contemporaneous, are produced in such stocks.

In some cases this orthogenetic or programme evolution may serve an adaptive end, but in others it seems to be unrelated to the environment and to have arisen from some restriction of the directions of variation possible to the stock.

Trueman emphasized the fact that this conception of the course of evolution is merely a statement of inferred fact and does not imply any such mystical belief in a planned evolution dependent on internal factors as is often supposed to be connoted by the term 'orthogenesis'.

Dr. P. D. F. Murray, discussing "Consequential Evolution", attributed some cases of 'orthogenesis', for example, the appearance at different times in different stocks of *Titanotheres* of horns at the same points on the skull and their subsequent enlargement with time, to the effect of heterogonic growth in animals the body size of which is steadily becoming greater. The factors, genes perhaps, which determine the horns were present throughout the series, but they could not be expressed below a limiting body weight, and once expressed, develop in accordance with Huxley's formula.

Captain C. Diver spoke on "Polymorphism"; he pointed out that this term is often used of such cases as those found in mimetic butterflies or in the land snails of the genus *Cepæa*, where a number of easily recognizable and discontinuous varieties of a single species occur in the same population. Such cases are necessarily restricted to those in which the variable characters are readily visible, but the condition presumably exists in many species where it affects physiological or other characters which cannot be seen directly. This apparent discontinuity between the polymorphic forms of certain species, however, grades imperceptibly into a continuous variation, and can only exist if all the polymorphic forms are in equilibrium with their environment.

Species apparently differ very greatly in their variability; in *Cepæa* there is a very wide discontinuous series of patterns and colours, occurring in parallel form in two distinct species in England and being hereditable. In the common water snail *Limnæa peregra*, there is no polymorphism in the ordinary sense, but there is a very wide variability, some of the conditions being transmitted by inheritance whilst others have no known relationship to any factors of environment or breeding. In the plant, *Plantago maritima*, we have a case in which polymorphism is combined with a considerable ecological plasticity.

Mr. J. Z. Young, in a witty and illuminating address, considered the broader features of the evolutionary process. He pointed out that all life depends on the isolation from an environment of an individual which differs in its chemical and physical condition from it, and that this individual, which is necessarily dependent on its surroundings for all its supplies, can only be maintained by the expenditure of energy. In this conception perhaps lies a meaning of the distinction between higher and lower organisms. The lower organisms differ as little as possible from their environment, so that their irreducible expenditure of energy on maintenance is as small as possible; the higher inhabit more and more difficult environments, from which their own internal environment differs more and more greatly, the work which has to be done in maintaining the differences becoming progressively heavier.

It was suggested that this power of colonizing difficult ecological niches, and the increasing number of biological tricks which go with it, is a test of a high organism.

The original Darwinian explanation of evolution by the "preservation of favoured races in the struggle for existence" has as its primary postulate a differential death-rate, natural selection favouring the survival—perhaps as individuals, perhaps as stocks—of those variants which best fit the circumstances in which they are living. It has, in practice, proved extremely difficult to show by direct observation, on a scale sufficiently large to allow the necessary statistical treatment to be applied to the data collected, that this selective death-rate does exist.

The explanation of this difficulty has been given by the work of Prof. J. B. S. Haldane. He has shown that a very small selective advantage applied to one of two allelomorphic characters will, in what, from a geological point of view, is a small number of generations, produce very large effects.

In the discussion, Prof. R. A. Fisher pointed out that the accuracy obtainable in well designed and conducted field trials of crops, which afford a very close parallel, is far too little to show a selective advantage of a size which in Nature would have an enormous influence. But the

possibility which now exists of predicting the proportions in which characters with a Mendelian inheritance present in a population should occur in the absence of selection, makes it possible by an analysis of large collections made from an interbreeding population to show the existence of natural selection and even to measure its intensity.

Prof. Fisher pointed out that polymorphic species, of the type described by Captain Diver in *Cepæa*, provide an exceptional opportunity of estimating the intensity of such selective agencies. By analysis of data of populations of grouse locusts collected by Prof. Nabours, he was able to show that certain dominant characters must possess a selective advantage of more than five per cent to outweigh certain genetic disadvantages which they possess, in order that they may occur in the proportion they do in the collections.

The afternoon session was devoted to the more restricted field of species formation and the isolation on which it may often or always depend.

Dr. E. B. Worthington pointed out that the effects of isolation can best be studied in such limited environments as those presented by fresh waters. Such areas may be geographically completely separated from one another, and in such the presence of a high selection pressure by predators, which may be expected to act most intensely on the not completely equilibrated intermediate stages in species formation, will reduce the rate of evolution.

But geographical isolation may involve and pass into the ecological isolation discussed by Dr. W. B. Turrill. He produced examples of speciation correlated with ecological isolation, and perhaps sometimes initiated by it.

Dr. W. H. Thorpe dealt with the special case of ecological isolation presented by the restriction of certain parasitic insects to one host and of other insects to one food plant. The isolation so brought about may lead to the production of forms which, whilst they are morphologically almost indistinguishable, may be sterile when crossed. He described experiments which showed that this restriction to definite hosts or food plants may depend on the 'conditioning' effect of the odours smelt by the insects on emergence, and that it is possible in some degree to condition such insects to quite unfamiliar odours.

Perhaps the most generally important and interesting modes of isolation of certain individuals which may represent a potential new species are those which arise from internal factors genetically determined. These internal factors may act in many ways: they may depend on a different time of maturity of the eggs and sperms in the two groups considered, or on a mechanical inadaptation preventing mating or on a failure of the mating instinct, or in known cases in plants on an inappropriate rate of growth of the pollen tube on the stigma of the other race. But all these things are most unlikely to depend on the action of a single gene, which could arise by one single mutation; they involve the interaction of a group of genes which even if it came into existence accidentally would immediately fall apart again unless it were held together by isolation.

Probably the most common and certainly the most satisfactorily established modes in which such isolation may arise are those which depend on modifications in the chromosome complement of the nucleus. Polyploidy may very generally lead to sterility between the parent and the new form, even when the latter is self-fertile, by preventing the successful pairing of chromosomes in meiosis. But such accidents as the inversion of a short length of a chromosome, or the detachment of a part of one chromosome and its subsequent adhesion to another not only lead to sterility, partial or complete, between the abnormal form and its parent, but also produce changes in the phenotype, the adult individual, even without any actual gene mutation. The general position was stated by Dr. C. D. Darlington, and some special cases were explained by Dr. D. G. Catchside.

Finally, Dr. S. C. Harland gave a most illuminating account of the genetics of cotton. He showed that wild cottons are to be found in most continents and that whilst some of them have thirteen chromosomes, others, including all the cultivated forms, possess double that number. But he then went on to show that by crossing domesticated cottons with 13-chromosome species from America and Asia, the nature of the tetraploidy can be analysed, and that it has become clear that the condition has not arisen by a mere doubling but represents the addition to one another of the chromosomes of both the American and the Asiatic types. A future conclusion is that plants of very similar structure may owe their characters to quite different non-homologous genes. Dr. Harland also showed that a gene introduced by crossing into a novel environment may mutate at an exceptionally high rate.

The whole discussion—although some important principles, mutation pressure for example, were not referred to—gave a very vivid picture of the present position of our knowledge of the mechanism of evolution. It brought out the immense extent to which the recent very rapid advances in genetics and in cytology have removed some old stumbling-blocks, and made it possible to discuss the whole subject anew and even to design experiments intended to solve problems now for the first time capable of being posed in definite terms.

D. M. S. W.

Post-Glacial History of the Fenland

THE Fenland Research Committee was established in 1932 under the presidency of Sir Albert C. Seward, and an attempt to synthesize the main results of its activities was made in a joint discussion held at Cambridge by Section C (Geology) and Section K (Botany), which may be briefly summarized as follows.

The deposits in which the history of that region is recorded have been examined in drains, in excavations made on specially selected sites, and in natural exposures eroded by the sea along the coast. These deposits consist of vast sheets of marine silts and fen peats interleaved with one another. The peats are most fully developed towards the landward side, where they tend to become rich in forest debris, and often enclose the stumps and boles of fallen trees. On the seaward side they thin away into insignificance between marine silts. The general story of the region is therefore one of changes in the relative levels of land and sea, resulting sometimes in periods of daily inundation by the tides, sometimes in periods when the ground was covered by fen, brushwood or forest.

The floor upon which the deposits lie comes up to the surface around the margins of the fen country, and in low hills which in prehistoric times rose up as islands in the watery waste. These islands, which often provided sites for human habitation, became partially buried under the gradually accumulating silts and peats. Excavations on one such site, near Shippea Hill station, have shown that successive generations left relics of their culture on the dry ground or dropped them in the adjoining fen. The latter have been preserved in the peat and have furnished evidence for establishing a correlation between the physical changes and the stages in human culture.

The earliest post-glacial deposits found consist of peat lying along the valleys excavated in the underlying floor. The composition of this peat points to the existence of woods consisting mainly of birch and pine growing on the adjoining higher ground and indicates a climate that was warm and dry. About 5500 B.C. the climate became more moist and remained so until about 2000 B.C. During this time the area became occupied by sedgy fens in which peat was formed, and by patches of brushwood on drier ground; and was fringed by forests in which alders were common. The opening of this period coincided with the dawning of the New Stone Age and the coming of Mesolithic man. The later-formed peat, however, yields traces of a more typically neolithic culture. In this respect, as well as in its composition, this peat resembles that seen at the lowest spring tide on the coast between Skegness and Mablethorpe, with which it may be regarded as being in part at least contemporaneous.

There now intervened a time of slow subsidence during which the sea inundated much of the peat-covered area, and buried it under an accumulation of silts and clays which have yielded foraminifera and diatoms of brackish water type. On the coast the corresponding deposits are eight to ten feet thick and are crowded with the remains of salt-marsh plants, a fact which shows that the subsidence that made the inundations possible proceeded very slowly. Eventually it ceased, and the saltmarsh gave place to fen and to conditions favourable to the formation of peat. In the vicinity of Ingoldmells, north of Skegness, the ground became sufficiently dry for the growth of brushwood, but remained sufficiently near to sea-level for sea water to penetrate inland along tidal channels. This combination of conditions favoured the establishment of numerous primitive salt workings. The debris from these has yielded pottery fragments characteristic of the early iron age, thus fixing a date, about 400 B.C., for the complete cessation of the slow subsidence described above.

Archæological evidence based upon the distribution of Bronze Age finds in the Fenland is strikingly in accord with the course of physical events outlined above. During the Early Bronze Age, settlement was relatively dense especially in the south. With the passage of time a gradual evacuation took place which reached its culmination in the Early Iron Age. There is little doubt that this movement of population was associated with the gradual extension of unfavourable conditions produced by the encroachment of high tides.

The almost complete absence of later Iron Age man from both the fen- and marsh-land is an unexplained mystery. At least so far as the latter region is concerned, subsidence had ceased before the opening of the Iron Age, and the level remained practically stationary until the last century of the Roman occupation, for the small Roman site at Ingoldmells Point, which was occupied during the first three centuries, lay close to the same level as that of the salt-workings. Moreover, as pointed out by Mr. C. W. Phillips, agriculture of a native type was carried on extensively in the Fenland during the first century and continued until the

fourth. There seems to be no reason, therefore, why Iron Age man should not have occupied the area during the preceding centuries.

In the coastal exposures the saltworks debris and the Roman site are covered by marine silts and clays yielding the shells of such organisms as the cockle, the oyster and *Scorbicularia*, which normally live just above or below the lowest springtide levels. As the tidal range is here as much as 20 ft., it is evident that a rapid subsidence of that amount took place at the close of and immediately after the Roman occupation. This must have rendered extensive areas uninhabitable. That this was the case also in the Fenland is proved by evidence forthcoming from Welney, which shows that sea floods occurred there at the end of the second century. Mr. Phillips, in summing up the archæological evidence, says, "In Anglo-Saxon times this region was again a wilderness", indicating that this state of affairs must have become worse and remained so for centuries.

H. H. S.

Magnetic Alloys and Problems of Metallic Structure*

THE general character of the variation of magnetization of ferromagnetics with field is well known. Different materials differ widely in their low-field characteristics, and in recent years there have been enormous advances in the production of materials with improved properties for particular technical applications. For permanent magnet materials, for example, the value of $(BH)_{max.}$ on the demagnetization curve (a measure of the effectiveness, being approximately inversely proportional to the volume of material required to produce a given external field in a given volume) is greater by a factor of about 5 in the modern iron-nickel-aluminium alloys (developed since 1931) than in tungsten steel, the best permanent magnet material available twenty years ago. For 'soft' magnetic materials the improvements have been no less spectacular, notably through the development of iron-nickel alloys. For the most part, the improved materials have been the result of systematic empirical research. An understanding of the factors determinative of magnetic characteristics is, however, clearly desirable, not only from a purely scientific point of view, but also from the point of view of the control, and further development, of technically desirable properties. In this article a brief account is given of the present outlook on the general theoretical problems involved, and also of recent experimental work illustrative of the manner in which the fundamental problems may be attacked.

Many of the properties of ferromagnetics can be formally correlated by supposing that the elementary magnets, electron spins, are acted on by a quasi-magnetic molecular field proportional to the intensity of magnetization. This gives rise to spontaneous magnetization, decreasing with increasing temperature to zero at the Curie point. Ordinarily the spontaneous magnetization is unidirectional only over limited regions, domains, and the effect of an external field is to align the directions of magnetization of the domains. Except near the Curie point, the magnitude of the intrinsic magnetization is not appreciably changed, so that the ordinary saturation magnetization provides a measure of the spontaneous magnetization. A basic characteristic of ferromagnetics is the variation with temperature of the spontaneous magnetization. The number of effective spins per atom is given by the saturation magnetization at low temperatures, while from the Curie temperature an estimate can be made of the magnitude of the quantum mechanical interchange interaction which gives rise to the molecular field effects. The effective spins in the ferromagnetic metals, iron, cobalt and nickel, correspond to the number of 'holes' in the incompletely filled electronic energy bands in the metals associated with the *d*-electron states in the free atoms. Owing to the manner of overlapping of bands, the number of effective spins per atom will not in general be integral, in accordance with observation. Moreover, the effect on the saturation magnetization of additions of a second element is readily interpreted, at least in the simpler cases,

* This article incorporates some of the material presented at a symposium in Section A (Mathematical and Physical Sciences) of the British Association at the Cambridge meeting on "Magnetic Alloys and X-Ray Structure" held on August 19, in which the following speakers took part: Prof. W. L. Bragg, Dr. E. C. Stoner, Dr. A. J. Bradley, Dr. W. Sucksmith, Mr. D. A. Oliver, Prof. W. Gerlach. A general survey of the field by industrial and university workers is given in "Magnetism" (London: Institute of Physics, 1938). Recent developments in magnetic materials are comprehensively reviewed by C. E. Webb (*J. Inst. Elec. Eng.*, **82**, 303; 1938). Magnetization curves are fully discussed in a series of lectures collected and edited by R. Becker, "Probleme der technischen Magnetisierungskurve" (Berlin: Springer, 1938). For the X-ray study of the iron-nickel-aluminium system, see A. J. Bradley and A. Taylor, *Proc. Roy. Soc.*, A, **166**, 353 (1938).

as corresponding to the filling up of the holes in the unfilled band by loosely bound electrons of the added element.

The form of the magnetization curves depends in a complicated way on a number of secondary effects the elucidation of which is linked up with that of the status of domains. The hypothesis of domains is fully confirmed by experiments on the Barkhausen effect, which show that the irreversible changes of magnetization on the steep parts of the magnetization curves are essentially discontinuous, the discontinuities corresponding to reversals, or changes of direction through large angles, of the electron spins associated with aggregates of atoms, ordinarily much smaller than crystalline grains, but containing as many as 10^{10} to 10^{15} atoms.

In an ideal single crystal the direction of magnetization of a domain would be along one or other of the equivalent 'easy axes' of the crystal, for iron along a cube edge. The effective crystalline anisotropy is, however, greatly modified by strain, and in ordinary polycrystalline material the course of magnetization is largely conditioned by local strain inhomogeneities. The strain distribution is probably largely determinative of the magnetic domain structure. In the initial part of the magnetization curve, the increase of magnetization may be attributed to reversible shifts of domain boundaries, the shifts being greater, and the initial permeability higher, the smaller the strain gradients, and the smaller the magnetostriction. When a boundary reaches a position of maximum potential energy, a comparatively large irreversible shift, corresponding to a Barkhausen discontinuity, can occur, the necessary field depending on the local strain amplitude. The connexion with coercivity is obvious. In the final stages of magnetization there is a gradual turning of the directions of magnetization of the domains towards the direction of the field.

Much still remains to be done in the quantitative development of these ideas, though formulæ which have been derived showing an inverse proportionality between maximum initial permeability and magnetostriction are in satisfactory agreement with experiment. For high coercivity large internal strains are necessary. These can be most effectively produced in heterogeneous alloys of the dispersion hardening type.

The mode of experimental attack on problems of the magnetic properties of alloys may be illustrated by reference to recent work on iron-nickel-aluminium permanent magnet material. With the ternary alloys the most effective composition is approximately Fe_2NiAl. Both quenching and very slow cooling give a material with comparatively low coercivity, high coercivity being obtained by a carefully controlled intermediate rate of cooling. A first requirement in the understanding of alloy properties is a knowledge of the phases present. Following earlier work, a very comprehensive X-ray study of the Fe-Ni-Al system, involving the preparation and examination of nearly 150 alloys, has been carried out by Bradley. This enables the phase boundaries in the room temperature ternary diagram to be accurately mapped. A special study was made of the Fe_2NiAl alloy. At high temperatures this is a single body-centred cubic phase, as shown by the examination of quenched specimens. On slow cooling it breaks up into two body-centred phases, $Fe_{2n}NiAl$ (nearly pure iron) and $Fe_nNi_7Al_7$, with slightly different lattice spacings. On cooling at the rate appropriate for the development of maximum coercivity, the segregation is incomplete, and the state corresponds to the occurrence of small 'islands' of iron-rich material held in the parent lattice spacing, and consequently under great strain.

The magnetic properties of the alloys used by Bradley are under investigation by Sucksmith, who is examining the temperature variation of the saturation magnetization. An extraordinarily interesting series of curves has been obtained which will be of the greatest value for consideration in relation to the X-ray data. The annealed Fe_2NiAl material gives a curve which agrees closely in form with that for pure iron, with the same Curie temperature, and a maximum magnetization about half as great. The quenched material gives a curve which at low temperatures is similar to that for Fe_2Ni diluted with aluminium (tending to a Curie point at about 400° C.), but at high temperatures, as annealing proceeds, it approaches the curve for the annealed material.

Of other recent work on these permanent magnet materials may be mentioned that of Oliver, who has found that cooling in a magnetic field results in an increase of remanence of about 8 per cent. The effect, which is large enough to be of possible technological value, may be linked up with the increase of permeability of ferro-nickels under similar conditions, investigated by Bozorth and Dillinger. Extensive work has also been carried out on the effect of impurities, and on tolerance limits of composition.

Ferromagnetism is usually regarded as a somewhat specialized subject, partly because ferromagnetic properties are confined to a comparatively small number of substances. Many general problems of the metallic state can, however, be approached most effectively through the study of ferromagnetics, just because a readily investigated index of the internal state is provided by the magnetic characteristics. The basic magnetic

properties give very direct indications of the state of the electrons in the metal, and of the character of the interactions; these indications can be carried over to metals generally. The low field behaviour provides indications of the nature and distribution of internal strain irregularities. There is no reason for supposing that domains, as regions of uniform strain, are peculiar to ferromagnetics; they are rendered apparent only because of the associated magnetic effects. The more complete study of low field properties should form a promising line of approach to the general problem of structure-sensitive properties. Ferromagnetic alloys combine points of immediate interest to workers in many different fields, industrial and academic, experimental and theoretical, and it may be hoped that further co-operation between them will result in rapid progress in connexion with problems not only of magnetic alloys, but also of metallic structure generally. E. C. S.

Nuclear Physics

THE discussion on nuclear physics arranged to take place in Section A (Mathematical and Physical Sciences) on August 18 was introduced by Prof. Niels Bohr, of Copenhagen, who gave an account of the new ideas in nuclear theory which have developed under his guidance during the last few years. The old nuclear theory attempted to explain the interactions of fast particles with nuclei by considering the behaviour of single particles inside the nucleus rather on the same lines as in the theory of the outer electronic system. This picture gave a satisfactory account of the penetration of charged particles into light nuclei but failed to account for many phenomena, in particular the large probability of capture of slow neutrons by nuclei relative to the probability of elastic scattering. These difficulties have been removed by the realization that owing to the tight packing of particles within the nucleus, there is a great facility of energy exchange between the particles. In consequence, when a particle penetrates a nucleus its energy is rapidly distributed amongst all the particles, resulting in a general increase in 'nuclear temperature'. The nucleus then remains in the excited state until sufficient energy is again concentrated on one particle for 'evaporation' or escape to occur. Alternatively, the state of excitation may decay by emission of radiation, but owing to the high symmetry of charge distribution, dipole radiation is in general unlikely and the decay period consequently long. The 'intermediate nucleus' thus exists for a period long compared with the time which would have been taken for the incident particle to traverse the system unhindered.

The study of the properties of this intermediate nucleus, its states of excitation and rates of decay, is the point of greatest interest to-day in nuclear physics. Prof. Bohr showed how much guidance as to its properties can be obtained from simple mechanical models. Thus the system behaves in many respects like a drop of fluid, and the states of excitation can be compared with the oscillations in volume and shape of a sphere under the influence of its elasticity and surface tension. The experimentally established result that the distance between excited levels diminishes rapidly with increasing excitation energy suggests also that nuclear frequencies can be formed from a linear combination of a few fundamental frequencies. The level distribution is therefore of a similar character to that of the quantum states of a solid body, and suggestive analogies occur between the absorption of infra-red radiation in solids and the absorption of high-energy γ-rays by nuclei. In such a way the results of Prof. Bothe on the wide variations in efficiency of disintegration of different elements by such -rays might be explained.

The energies of the stationary states can be obtained from experiments of the type described by Mr. P. I. Dee and Prof. W. Bothe. It is observed that many nuclear processes show resonance effects —that is, they occur with maximum intensity for a particular range of energy of the incident particle. This resonance is explained by the sum of the energy of the incident particle and the original nucleus coinciding with the energy of a stationary state of the compound nucleus. The compound nucleus may decay either by the emission of charged particles, neutrons or γ-rays, and in consequence the intensity of the emission of such radiations will show resonance maxima as the energy of the bombarding particle is changed. The Cavendish Laboratory experiments determined the intensity and energy of the γ-rays emitted when beryllium, boron, carbon and fluorine are bombarded by protons. Resonance maxima were observed for beryllium at 350 and 670 kilovolts; for boron at 180, 650, 850 and 950 kilovolts; for the

carbon isotope of mass 12 at 480 kilovolts; for the carbon isotope of mass 13 at 570 kilovolts and for fluorine at 330, 470, 590, 670, 860, 920 kilovolts. The fluorine experiments are particularly interesting in showing the closeness of the levels of ^{20}Ne when excited to 13·5 million volts. A further point of interest is the 'breadth' of the different nuclear states. Sharply defined energy states and sharp resonances occur when the lifetime of the state is long, that is, when the probability of decay is small. In the above cases, the resonance occurs because decay of the excited nucleus by particle emission is improbable. The experiments determine only an upper limit to the breadth of the states owing to the spread in the energy of the incident particles (about 20 kilovolts).

Prof. Bothe's experiments measured the intensity of emission of α-particles, neutrons and γ-rays from the same intermediate nucleus. He found that although some resonance levels are observed for all the radiations, others occur only for one type of decay, a result which introduces some difficulty for the view that the different radiations are competing methods of decay from the same nuclear state.

Another method of determining energy levels of nuclei depends on observing the energies of the different groups of particles emitted when an excited nucleus returns to stability. Thus when fluorine is bombarded by deuterons, the compound nucleus ^{21}Ne emits four groups of α-particles, the most energetic group occurring in a transition to the ground state of ^{17}O and the other groups in transition to excited states of ^{17}O. Thus excited states in ^{17}O at 0·83, 2·95, 3·77 and 4·49 million volts are found. One of these was already known to be produced when oxygen is bombarded by deuterons; two have been determined from experiments by Gilbert and by Bothe on the disintegration of neon by neutrons. Thus different methods of formation of a nucleus show in general the same excited states.

In some nuclear reactions the residual nucleus may be left in a metastable excited state in which it has only a small chance of decay by γ-ray emission. This may occur when the angular momentum of the metastable state differs by several units of $h/2\pi$ from that of the ground state. We may then have two nuclei of the same mass and charge but with different properties. Dr. N. Feather described cases of such 'isomerism' in the pair uranium Z and uranium X_2 and in ^{108}Ag. In the decay of these nuclei, when transition to the ground state is improbable, the nucleus usually loses its energy of excitation by transitions to one or more intermediate states so that several quanta are emitted in succession. Experiments of Feather and Dunworth have shown that two quanta are emitted in succession from uranium Z, and four or five in succession from the long-lived isomer ^{108}Ag.

Other evidence for the formation of isomeric metastable states was presented by Dr. M. Goldhaber. Experiments carried out in collaboration with Mr. R. D. Hill and Dr. L. Szilard had shown that a metastable excited state of ^{115}In, designated by ^{115}In*, of 4·1 hr. half-life time, can be formed by bombarding indium with fast neutrons of as low as 2·5 m.e.v. energy (D + D), but not noticeably with photo-neutrons from radium plus beryllium which have energies of a few hundred thousand electron volts. It was shown by successive chemical separations that the same radioactive isotope, ^{115}In*, is also formed when ^{115}Cd (2·5 days) decays emitting negative electrons. ^{115}Cd was obtained by the reactions ^{116}Cd $(n, 2n)$ and ^{114}Cd (n, γ). ^{115}In* (4·1 hr.) can be easily studied free from ^{117}In (2·3 hr.), previously reported by Cork and Thornton, which is found in these experiments to have a 4 hr. cadmium parent. The properties of ^{115}In* are of great interest, and preliminary investigations show that it emits negative electrons of 550 ± 100 k.v. maximum energy, as well as γ-rays consisting of a hard component of 320 ± 50 k.v. energy, and a soft component, probably K-radiation of indium. It is therefore likely that ^{115}In* decays in three different ways, partly into its stable isobaric neighbour ^{115}Sn with emission of β-rays, and partly into ^{115}In, whereby the excitation energy is emitted sometimes in the form of γ-rays, and sometimes by internal conversion.

A quite independent line of attack on excited states of nuclei was reported by Mr. S. Devons, who has studied the scattering of α-particles by helium, carbon, nitrogen, oxygen and fluorine. The α-particles scattered through a fixed angle were detected by an annular counter and the numbers recorded as a function of α-particle energy. In place of the smooth curves obtained in the earlier experiments where resolving power was small, very well defined resonance peaks now appeared, the different peaks corresponding to the different wave components by which the incident particle could be represented; the energies giving the excited states of the compound nuclei.

New experimental methods for the determination of the resonance levels occurring with neutron capture were reported by Dr. P. B. Moon and Prof. C. D. Ellis. The method developed by Dr. Moon and Dr. C. E. Wynn-Williams produces pulses of deuterons by modulating the input to a source of deuterons. The deuterons in turn produce pulses of neutrons, and these neutrons produce disintegrations at a fixed distance from the

source. If then the time of the disintegration is recorded by a cathode ray oscillograph, the time taken by the neutron to travel from its source is determined and thus its velocity is found. It is therefore possible to determine with much more precision than hitherto the energies of neutrons producing particle disintegrations. This method is similar in principle to work recently reported by Alvarez in which the output of the Berkeley cyclotron was modulated.

Prof. Ellis reported a simpler method of determining resonance levels in nuclei in which a lead or bismuth absorber is placed at varying points in a pile of paraffin plates separating the source from the neutron detector. Maxima in the yield of the detector are observed as the absorber position is changed. By substitution of a boron absorber for the lead or bismuth, the energies of the absorption bands can be determined. Thus two levels have been found for bismuth at 1 and 10 volts and a level in lead at 11–12 volts.

Dr. J. D. Cockcroft and Mr. Dee described the new Cavendish Laboratory equipment for nuclear research which has been provided by the benefaction of Lord Austin. A High Voltage Laboratory has been equipped with generators for 1·2 and 2 million volts, and a vacuum tube for accelerating particles by 1·2 million volts has been in operation for a year. A tube for 2 million volts has just been erected and is going through its trials satisfactorily. A cyclotron has also been built to produce deuterons of 12 million volts energy. The apparatus includes a 50-ton magnet and a 100 kilowatt short-wave oscillator of accurately controlled frequency. The assembly of the apparatus has just been completed, and the first indications of a 'beam' of deuterons has been obtained with the apparatus adjusted to produce 10 million-volt particles.

Low Temperature Physics

FOR many years, interest in low temperature physics was largely confined to the phenomenon of superconductivity. During the past four years, however, new phenomena have received attention, and at the session of Section A (Physics) on August 22 devoted to low temperature physics, comparatively little time was devoted to superconductivity. Attention was concentrated instead upon the Debye-Giauque effect, that is, the cooling of certain paramagnetic substances by adiabatic demagnetization, and upon the curious phenomenon of liquid helium II.

As Dr. H. B. G. Casimir pointed out in his discourse, the problems of low temperature physics fall into three categories: (1) non-magnetic insulators; (2) magnetic insulators; and (3) metals.

The phenomena to be observed in the first category are mainly extensions of those appearing at higher temperatures, such as specific heat, thermal conductivity, etc. Measurements of such phenomena agree well with theories developed by Debye, Born, Peierls and others. In general, it may be said that, with one great exception (and always excepting possible future discoveries), this branch of low temperature physics is concise and definite, and that there remain only further technical measurements to be made. The great exception is liquid helium II.

The low temperature modification of liquid helium known as liquid helium II was discovered a little more than ten years ago by Onnes. Two theories have been put forward to explain its peculiar properties, neither of which has been disproved, although the weight of evidence in favour of either is not very great. What may be called the order-disorder crystalline theory, to which contributions have been made by Simon, F. London, Fröhlich, Jones and Keesom, gives a successful interpretation of the negative expansion coefficient, the high and discontinuous specific heat, and the momentum transfer which accompanies heat flow. The fact that the substance has a very small viscosity, however, makes the validity of such a crystalline theory seem doubtful.

F. London has proposed alternatively that helium be treated as a degenerate Bose-Einstein gas. The discontinuity in the specific heat can be explained if certain assumptions are made concerning atomic interactions. Tiza has enlarged the theory to explain the flow and conductivity phenomena which are observed. In the Bose-Einstein picture, liquid helium II is composed of a great many 'condensed' atoms in the ground state, that is, a 'super-fluid' of no viscosity, and a few atoms in high energy states, in other words, a 'gas'. The pressure-independent capillary flow observed for the substance would then be governed by the rate of heat gain or loss in flowing in and out of a reservoir. This theory, too, has been neither

proved nor disproved so far. Heat flow and fluid flow are, however, closely bound together, and are further complicated by the rapid transfer of liquid helium II in the form of surface films on every surface immersed in the liquid. This means that although the experiments on the problem are quite simple and classical in type, they are invariably exceedingly difficult of true interpretation.

The second category of substances differs from the first in that the cessation of influence of thermal vibrations in the crystal lattices results in greatly enhanced magnetic effects. The phenomenon of absorbing interest is the remarkably low temperature observed on adiabatic demagnetization of paramagnetic salts. Although the effect was predicted by Debye several years before it was discovered by Giauque, many details of the process are still difficult to interpret. Prof. Van Vleck dwelt on several of these in his discourse on the magnetic theory of the process, and paid particular attention to the appearance of ferromagnetism in the salts at very low temperatures.

Measurements on the absolute temperature scale below 1° K. as determined from thermodynamic measurements on magnetically cooled salts were described by Prof. F. Simon. The accuracy of the measurements is quite high, but it is possible that they may be in error by 5 per cent at 0·1° K. These can be compared with the temperature as determined from the susceptibility measurements, which are those actually used in any demagnetization experiments. Since the temperature measured in this way depends by virtue of the demagnetizing factor on the shape of the specimen, Prof. Simon has suggested that until the absolute scale is measured more exactly, temperatures measured magnetically should be reduced to those determined for a spherical specimen and should be designated by the symbol T^*.

The process of adiabatic demagnetization can be most simply described as follows. At a sufficiently low temperature (1° K.) the energy content of a paramagnetic salt, such as iron ammonium alum, is mainly composed of the disorder of the magnetic ions. Isothermal magnetization to, say, 10,000 gauss, lowers the entropy of the salt at that temperature by reducing the disorder of the ions. Adiabatic demagnetization then does not alter the entropy, and hence the temperature is reduced to the neighbourhood of 0·05° K. The disturbing effects are the interactions of the magnetic ions with themselves and with the lattice. The second can be reduced by choosing a substance such as cæsium titanium alum, and the first by iron ammonium alum in which the ions form a small part of a very large molecule, and it can be somewhat further reduced by dilution of the salt so that the ions are still more separated from each other. One obtains an optimum value in this way, since too much dilution lowers the specific heat of the ions in relation to that of the rest of the substance.

A possible lower limit to temperatures obtained in this way might be put at 0·001° K. If we consider, however, the possible future use of the nuclear magnetic moments as a means of cooling, a two-stage process using a paramagnetic salt to cool a metal with a suitable nuclear moment which in turn is adiabatically demagnetized, it is possible that even lower temperatures might be realized.

Up to the present time, comparatively little has been done in the way of using magnetic cooling to reduce the temperature of other substances. Now that the absolute temperature scale is fairly well established, however, and we know that within a few seconds at most after demagnetization the lattice of the salt is in thermal equilibrium with the ions, we can expect much more investigation of other physical properties in the temperature range from 0·05° to 1° K.

In the third category of substances, that of metals, the theory built up by Sommerfeld, Bloch, Peierls, and others fails to explain the sudden appearance of electrical superconductivity in certain metals at low temperatures, although it does allow the resistance to approach zero at the absolute zero in an ideally pure metal. In spite of the great amount of data available on superconductivity, it remains almost completely mysterious. Many theories have been submitted to account for it but have failed, although a very promising phenomenological theory by F. London appears to be quite satisfactory within the scope of its application. It is almost certain that one cannot consider superconductivity as a one-electron problem, and that it must instead be treated as concerned with electron groups.

Considered thermodynamically, however, certain features, such as the 'threshold curve', that is, the temperature variation of the critical field for destruction of superconductivity, do admit of successful analysis, as has been shown by Gorter and Casimir. But the true nature of superconductivity still eludes us. Here again, although the experiments are in general simple, the difficulties of exact interpretation are very great. In spite of the fact that an enormous mass of data on superconductivity is at hand, a good deal of it is rather haphazard, as is natural when one is dealing with a mysterious phenomenon. Many more experiments must be carefully made under conditions of known metal purity in order that the mass of apparently disconnected small effects may be either proved spurious or fitted into the picture.

J. F. Allen.

Repercussions of Synthetic Organic Chemistry on Biology and Medicine

THE recent discussion* on "Repercussions of Synthetic Organic Chemistry on Biology and Medicine" held on August 23, under the auspices of Section B (Chemistry) of the British Association at the Cambridge meeting, directs attention to one of the most striking features of modern organic chemistry, namely, its increasing preoccupation with naturally occurring substances of biological importance. The reasons for this change of heart on the part of the chemist, long divorced from biology, are too varied to be dealt with here, but there can be little doubt that the development of microchemical technique has done much to render it possible. In a discussion such as that at Cambridge it was impossible to cover more than a fraction of the investigations in this field, but from the subjects actually chosen by the various speakers, it is possible to obtain a general view of the ways in which organic chemistry is affecting biology and medicine.

Intensive research in many centres on the nature of the various sex hormones has led to results of great interest. All these compounds belong to that group of natural products containing the ring skeleton of the sterols. Three classes of sex hormones are now well defined : the œstrone group, the androsterone-testosterone group and the progesterone group. Several natural compounds of the first group are known ; these have primarily the power to produce in female animals the changes in the reproductive tract characteristic of the time of ovulation (œstrogenic activity). The same is true of the second group, the members of which can stimulate the atrophic accessory organs and secondary sexual characters of castrated animals (androgenic activity) ; but in the third group progesterone is the only known naturally occurring substance which produces, to any marked degree, progestational changes in the female reproductive tract.

Synthetic closely related substances are known having similar biological activity to hormones of all three groups. Synthesis in the sterol-sex-hormone group, of course, refers to partial synthesis from other natural substances, since the fundamental ring system of the sterols has not yet been synthesized. The testing of a large number of synthetic substances related to the natural hormones has brought out a variety of points of great interest to chemists and biologists alike. It has been found, for example, that only derivatives of androstane are androgenic, and that the degree of activity depends largely on the nature of the substituents in positions 3, 5, and 17 in the nucleus (I) and on the stereochemical configuration of the compounds. Here, as in other groups of physiologically active substances, stereoisomers differ markedly in activity.

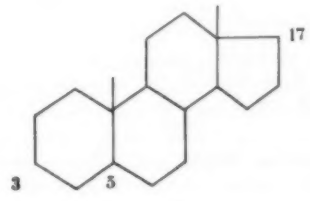
The structural differences between members of all three classes of sex hormones are relatively small, and biological investigations carried out with the natural and synthetic substances have brought to light the surprising fact that multiple activity is common in the sex hormone group. Thus it has been established that, in the above series of androgenic substances, many show weak œstrogenic, and some weak progesterone-like activity.

Work on the isolation of sex hormones from natural sources, too, has shown that male and female animals differ in the proportion of the various sex hormones rather than in their nature. The very close relationship between the various physiologically active steroids has been even further emphasized by the recent series of investigations on the hormones of the adrenal cortex. Efforts to isolate the 'cortical hormone' capable of maintaining life in adrenalectomized animals have led to the isolation from adrenal cortex of at least five different compounds possessing this property in varying degree, and it is probable that others will yet be isolated. All these substances are sterol derivatives resembling the sex hormones in structure. Deoxycorticosterone, the most active substance so far obtained, differs from progesterone only by having an additional hydroxyl group, and even shows some progesterone-like activity.

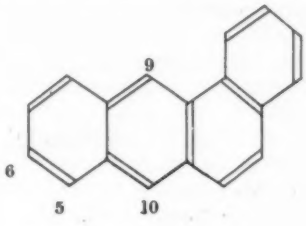
In fields other than hormone chemistry, too, considerable advances have been made in the determination of the structural features necessary for the exhibition of a particular effect by a given compound. Following on the isolation and identification of the hydrocarbons in coal tar which have the power of causing cancer, a large number of polycyclic hydrocarbons have been synthesized and examined for carcinogenic properties. Of these the most potent and best investigated are derivatives of 1 : 2-benzanthracene (II). In mono-alkyl derivatives of this hydrocarbon, carcinogenic power is possessed in increasing degree by those bearing the substituent in positions 6, 9, 5 and 10 respectively. In the case of poly-alkyl derivatives,

* Speakers at the discussion were Sir. F. Gowland Hopkins, Prof. E. C. Dodds, Dr. A. S. Parkes, Prof. L. Ruzicka, Prof. J. W. Cook, Prof. T. Reichstein, Prof. A. R. Todd.

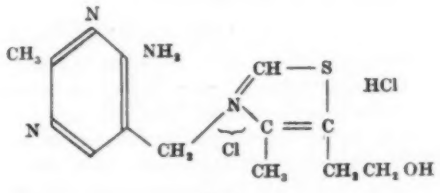
substituents present in these positions appear to reinforce one another, yielding some of the most potent carcinogenic agents at present known. To this group of 1 : 2-benzanthracene derivatives belong 3 : 4-benzpyrene, a substance undoubtedly responsible for skin cancer among coal tar workers, and methyl cholanthrene. The carcinogenic activity of the latter substance is noteworthy as it can be prepared in the laboratory from cholesterol and the bile acids, substances normally present in the body. There is some structural resemblance between many carcinogenic substances and members of the sterol-sex-hormone group, and the continuance of such investigations may bring us closer to a knowledge of the cause of cancer.



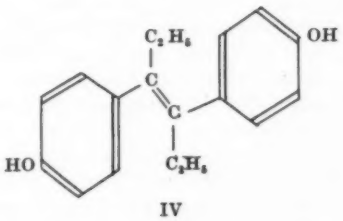
I



II



III



IV

In the field of vitamin chemistry, advances have been very rapid in recent years and a number of vitamins have been synthesized and have become available for medical and biological purposes. In the case of the antineuritic factor (vitamin B_1, aneurin), discussed at Cambridge, the availability of the synthetic vitamin has led to the discovery of many hitherto unsuspected uses in clinical practice, while the work at present being carried out on the part played by it in carbohydrate metabolism is giving us a clearer insight into its function in animal organisms. Many investigations have also been made with the view of ascertaining the structural details necessary for vitamin activity. In the case of aneurin (III), the investigations so far indicate a high degree of structural specificity, for apart from alteration in the nature and position of the alkyl group on the pyrimidine ring, little structural change in the molecule is possible without complete loss of activity. It would appear that less variation in structure is possible than in the case of the sex hormones. A high degree of structural specificity seems to be a feature of many vitamins.

A point brought into prominence by the work on aneurin is that our present classification of certain natural substances as 'vitamins' and of others as 'hormones' appears to be rather arbitrary, and recent work shows that a distinction between the two groups cannot always be upheld. For example, biological experiments have shown that aneurin, while it functions as a vitamin in animals, appears to be essential to plants as a root-growth factor, that is, it is a phytohormone. The female sex hormone, œstrone, also occurs in the vegetable kingdom, although its exact function there is not known.

Of late, much attention has been focused on the attempts to prepare relatively simple compounds possessing the biological activity of hormones or vitamins, a field of endeavour which, apart from theoretical importance, has an obvious practical interest in medicine. In experiments on the synthesis of œstrogens, striking results have already been obtained. By following out a scheme of simplification of the œstrone molecule, substances have been arrived at, the œstrogenic activity of which, astonishingly enough, far outstrips that of the natural hormone. To mention a particular case, the compound 4 : 4′-dihydroxy-α : β-diethylstilbene (IV), also known as stilbœstrol, has an œstrogenic power about ten times as great as that of œstrone. The compound at first sight appears to be wholly unlike the sex hormones in structure, but, theoretically at least, its conversion into a substance with a chrysene

skeleton might be readily achieved by a double ring closure. Whether or not this possibility has a bearing on its biological activity it is too early to say. In any event, this imitation of the effect of a hormone by a series of synthetic substances foreign to the body opens up a field with great possibilities. Medical and biological investigation of the properties of stilbœstrol are as yet incomplete, but present indications are that it has all the properties of an œstrogenic hormone. It would thus seem to be an artificial hormone-like substance of a type entirely different from, say, synthalin, which, although lowering the blood sugar like insulin, nevertheless does so in an entirely different manner from the hormone.

Generally speaking, there appear to be two types of investigation carried on by the organic chemist which have a direct effect on biology and medicine. One of these deals with the isolation, structural identification, and synthesis of substances responsible for particular biological effects, and the determination of the structural features in these compounds essential to activity. The other is concerned with the synthesis of simple compounds which will exhibit the same biological action as natural hormones and vitamins. Bearing in mind the old lock and key theory of physiological action, we might regard the first type as a search for Nature's keys and the second as an effort to prepare skeleton keys to serve similar ends.

Physical Chemistry of Clay

IT is a remarkable tribute to the liberal outlook of Section B (Chemistry) of the British Association that the four principal contributors to the discussion on clays held on August 22 at Cambridge were physicists. The basic principles governing the chemistry of the silicates are, as Prof. W. L. Bragg explained, clearly revealed in their crystal structure. Every silicon atom is surrounded by four oxygen atoms in tetrahedral arrangement. In olivine the $(SiO_4)''''$ groups are separate, while in silica and the feldspars each oxygen is a component of two tetrahedra. Between these extremes we find the pyroxenes and amphiboles, in which the tetrahedra are linked by common oxygens into parallel chains, and minerals, like mica, in which the tetrahedra are linked into parallel sheets.

Kaolinite is the best crystallized clay, and it appears reasonably certain from the work of Gruner and others that it contains sheets of linked tetrahedra. Three of the four oxygens of each tetrahedron are shared, and these oxygens form the base of the sheet. The middle layer contains the unshared oxygens plus half their number of hydroxyls, and the top layer consists entirely of hydroxyls. Between the middle and top layers are aluminium atoms surrounded in octohedral symmetry by four hydroxyls and two oxygens. The structure may be represented thus:

$$O_2\ Si_2\ O_2OH\ Al_2\ (OH)_2.$$

Montmorillonite, the principal clay mineral in bentonite and fullers' earth, gives rather poor X-ray powder diagrams, and single crystals large enough to be examined in detail have not yet been obtained for X-ray examination. Dr. G. Nagelschmidt explained that the mica-like structure proposed by Hoffmann, Endel and Wilm is probably correct, but it cannot be regarded as established, as the X-ray evidence is insufficient. Other tests can, however, be applied. The 'ideal' composition as exhibited by pyrophyllite is

$$O_2\ Si_2\ O_2OH\ Al_2\ O_2OH\ Si_2\ O_2.$$

Several authors have reported the loss in weight in the neighbourhood of 500° C. to be less than the 4 per cent that would bring the clay to $Si_4Al_2O_{11}$; but some recent measurements on fractionated bentonite are in agreement with this prediction. A critical study of the technique of dehydration is desirable. The chemical composition of montmorillonite is rather variable; but the silicon content never exceeds that of pyrophyllite. In view of the established structure of mica, it is reasonable to suppose that enough aluminium is present, replacing silicon, to complete the layers of linked tetrahedra, and enough iron and magnesium are present in the central layer to replace aluminium. The substitutions of aluminium for silicon and magnesium for aluminium cause the lattice sheets to be negatively charged, and cations must be present to preserve electrical neutrality. In a number of cases that have been worked out in detail, this structure satisfactorily accounts for the cations found. A few cases appear not to fit, and these require closer examination.

A striking characteristic of montmorillonite is that the spacing of successive lattice sheets varies reversibly according to the relative humidity, the intervening water layer varying from nothing to four molecules deep. The balancing cations are held in these water layers only by electrostatic forces, and are readily exchangeable for others carrying an equal charge. The thickness of the

water layer at a given relative humidity depends on the kind of cation that is present.

The fact that the number of exchangeable ions held by a clay depends upon the hydrogen ion concentration of the clay shows, as Dr. R. K. Schofield pointed out, that clay particles carry other electric charges besides those arising from isomorphous replacements. There are evidently 'spots' on the particles which are charged or uncharged according to the reaction of the medium. They are of two kinds : acidic spots, where negative charges can develop through the dissociation of hydrogen ions, and basic spots, where positive charges can develop through the combination of hydrogen ions. The process in the case of the acidic spots is probably

$$\equiv Si - OH \rightleftarrows \equiv Si - \bar{O} + H^+$$

the silicon atoms being those situated at the edges of the silicon-oxygen layer. The chemical nature of the basic spots is uncertain. They are not found in the clay minerals so far identified, but are frequent in the common clays. The equilibrium is possibly

$$- \overset{+}{Al} - OH \rightleftarrows - Al = O + H^+$$

and may be due to an overcrowding in the octohedral layers. In certain clays the number of basic groups exceeds that of the negative charges due to isomorphous replacements. These exhibit well-defined iso-electric points.

The forces which hold the successive lattice sheets together appear to be of three kinds. In the case of pyrophyllite and talc, both the faces of the sheets consist of oxygens shared between silicons, and only very weak residual fields are available to hold one sheet to the next. In kaolinite one face consists of oxygen and the other of hydroxyls. The layers are stacked with the oxygen layer of one sheet facing the hydroxyl layer of the next. In this case, Prof. J. D. Bernal explained that 'hydroxyl bonds' must here be regarded as providing the principal linkages. When the sheets are charged, the balancing ions act as ties. In mica the attractive force is strong enough to keep water out, but in montmorillonite, with fewer isomorphous replacements, water at high relative humidities can partially separate the sheets. The development of thixotropy in clay suspensions within a certain range of salt concentration is doubtless connected in some way with this effect, but Prof. E. K. Rideal mentioned cases where this behaviour seemed to be due to a small amount of the clay that had dissolved. Observations on the behaviour of clays towards water were made by Dr. E. W. Russell and Mr. H. H. Macey.

Problems of Crop Production

IN devoting a session on August 22 to problems of crop production, Section M (Agriculture) was dealing with one broad aspect of a wider question—the place of science in the advancement of British agriculture. More than simple efficiency of production is implied by advancement. It means also the development and extension of farming to the fullest economic degree and, if demonstrably necessary in the national interest, to a degree beyond the limit set by financial economics. Now advancement in the industry at large, like success on the individual farm, is dependent first on policy and next on technical farming efficiency. Science can promote efficiency both by providing new knowledge and by helping farmers to make the best use of existing knowledge ; that is, by research and by education.

It must have been in the minds of those who listened to this discussion to ask whether science's contribution must be limited to technical efficiency or whether it might not have a part in making national agricultural policy. Views put forward at an earlier session, when employment on the land was discussed, plainly inclined to the idea that in applying itself to agriculture, science must take national policy as it finds it and be content to work within its limitations. But ever since the end of the Great War, protagonists, some scientific, some lay, have claimed for science a strong share in government, including the shaping of policy. It may be regretted that, when discussing the part of science in agricultural advancement, the Section did not boldly debate the question what part, if any, science could take in shaping agricultural policy.

The title under which this discussion took place is significant—the practical problems of crop production. In conferences connected with science and agriculture it is usual to deal only with current experimental work. So much is this the case that discussion as to what are the main problems of crop production very rarely occurs. Yet it is the great problems of farming practice which agricultural science is under obligation to try to solve. In its efforts it constantly has to take up special problems in pure science. But the final objective must always be to help the agricultural industry.

The plan of discussion classified the problems

of crop production under husbandry practices, crop varieties, and damage by pests and diseases. The question of crop varieties may seem almost wholly for the plant breeder. In fact, however, it creates producer problems wherever crops are grown under even moderately intensive conditions. The basic consideration is which variety of the crop concerned will pay best. With modifications in special cases, yield first and next quality of produce, determine remunerativeness. Many farmers still cling pathetically to the hope of finding in some new variety a means of getting higher yields without greater effort on their own part. In undeveloped agricultures it may be fairly easy for the breeder to satisfy this hope. But with crops already highly improved, like British cereals, the plant breeder can do no more than produce varieties which will give higher yields—in a way that the older varieties cannot—under a higher level of husbandry. That is, the breeder can help the farmer to raise the level of output, but cannot solve for him the problem of raising or maintaining soil fertility.

The old question of the importance of high botanical uniformity of type among the plants in a field has aroused a new, more critical, interest. Among its many farming and genetic aspects, influence on quality of produce attracts most attention. It seems evident, indeed, that the whole question of quality ought to be re-examined. The farmer may be expected to concern himself about quality, whether in choosing the variety or in husbandry practices, only in measure as he is paid for quality. But what is this measure? Discussion revealed a feeling that modern household taste and modern processing technique are so developing as to divest quality of some of its importance in many crop products: and further, that to guide the farmer and to ensure reasonable price-recognition of quality, experimentally determined standards will have to be specified. Farmer and agricultural scientist cannot alone deal with this matter; consuming interests have a part to play and, in some cases, an urgent problem—to find out more clearly what they themselves require in quality of crop products.

The variety problem, from a plant breeding point of view, brought up a question which, though never under direct discussion, gloomily intruded itself more than once upon Section M—the question of Britain's agricultural policy. To produce a new variety by hybridizing may take fully fifteen years. Who is to say whether in fifteen years' time mangolds, swedes, turnips, kales, beans, peas will have dropped to the small acreage their decline of the past years suggests? Yet on this turns the wisdom of undertaking expensive breeding work on them. Their future place depends on the extent to which meat and milk are to be produced from arable land or from grass; and this question is perhaps as big as any in the future of our agricultural policy. It involves cereals, too, in the matter both of grain and of straw, and manifestly bears fundamentally on grasses and clovers. It is thus a prime determiner of the major practical problems not only of breeding but also of husbandry, both crop and animal.

In husbandry practices the problems of urgency are recognized to be not new questions but old ones made important: by new resources, such as mechanical power; by new conditions, such as world surplus in staples like wheat and sugar; by economic pressure under which land drainage has fallen into decay and cash crops have displaced livestock on arable land, in some minds to the permanent detriment of soil fertility.

The readiest example of such problems is cultivations. They include ploughing, cultivating, subsoiling, harrowing, hoeing, rolling. Whether their source of power be tractor, horse, or the bullock or hand tool of tropical countries, the modern cultivator has begun to ask himself questions about them. What, exactly, is their effect on soil and crop and, thus, to what extent are they necessary? Local custom once told a farmer how often to plough for a root crop and whether to plough fleet, medium or deep. He asks now whether anything is gained by cultivations beyond the minimum necessary to make a seed bed, bury large rubbish, and kill weeds. The tea planter in India or Ceylon, the sugar beet grower in Britain and his rival in tropical sugar cane countries, and indeed the grower of almost any crop anywhere, recognizes here a pressing question.

Maintenance of soil fertility is a problem of no less wide application but much greater gravity. Its crux is commonly held to be soil organic matter, and discussion showed sign of return to the view that the old, uncompromising rotational farming is the only sure foundation for maintaining soil fertility. Land drainage also came under review. This is overshadowed by the sorry fact that in present conditions owners and tenants cannot afford to restore or replace the old land drains which have been vital to British farming since about 1840–60. Tractor power has made a new contribution to mole draining, but there remains the great difficulty that we have but crude ideas as to the influence of depth, distance apart, and orientation of drains. It was held that the final solution of these practical problems could only be found in a full knowledge of water movement in various soils.

Past experiment on cultivations and on the control of fertility by fertilizers, manures and farming systems, reveals a conception of problems not acceptable from the point of view taken in this

discussion. It was formerly the object of experiment to find out the effect of any treatment on the immediately following crop and on that alone. Now the practical problem is widely accepted to be the cumulative effect of these methods and treatments on the soil and on the yield of all the crops throughout a rotation.

Science cannot solve the exact problems which confront the farmer. It has to ascertain the scientific questions by which the practical problem is made up and to deal with these. In the case of cultivations and maintenance of fertility, the simplest kind of investigation would be field trials to measure the effect of various treatments on crop yield. Such measurements would not give understanding or point the way to further progress. Here the questions for science are how each cultivation or other treatment influences the soil and directly, or through the soil, the crop. These influences can only be measured by the plant itself. That is, a developmental study must be made to determine how at each point in plant life treatment influences growth and development and thus, ultimately, final yield. To make developmental studies under field conditions is exceedingly difficult. Plant physiology could do a service to agricultural experimentation by devising measures or indexes of growth and development suitable for field use.

In dealing with pests and diseases of crops, the natural tendency towards vigorous offensive may overcome business common-sense. Prominence was given in the discussion to the need for careful estimates of extent and nature of damage to crops. To find a method of control or prevention is not the full solution of the practical problem; how much can profitably be spent in applying the method remains, in many cases, a problem also.

Of plant parasites—insect, fungus or other—the types most to be dreaded are those capable of lingering in the soil for several years. Examples are 'take all' (*Ophiobolus graminis*) of wheat and eelworm of potatoes or sugar beet. No direct means of destruction is known in any of these cases, though indirect methods, sometimes biologically fascinating, are coming within view. Safety lies at present in avoidance; in a policy of temperance. In fact, what was said from the husbandry point of view in the discussion, about the merits of uncompromising rotation, was effectively reinforced by considerations of disease. The apparently steady increase of take-all, foot root and similar diseases in cereals, in many parts of the world, was declared to arise from the tendency to lessen the interval between one corn crop and the next. Correspondingly, the tendency and the temptation to grow successive crops of early potatoes or sugar beet has already created a problem of geographic extent and of gravity which few realize. Restriction on freedom of cropping—in the past a matter of statute law and leases—has its severest importance as a matter of biologic law and herein lie, perhaps, the greatest problems of plant pathology.

Present Aspects of Plant Virus Research

THE discussion on present aspects of plant virus research, held on August 23 by Section K (Botany) at Cambridge, covered the whole range of plant virus work, from the properties of purified virus proteins to the propagation of healthy potato stocks.

Recent work by Dr. Kenneth M. Smith and Mr. W. D. MacClement, on the natural modes of dissemination of plant viruses, has shown that the old idea of an insect vector as essential for the spread of a virus from plant to plant is true only to a limited extent. Some of the best known viruses apparently have no insect vector and other means of dissemination must exist. *Solanum* virus I spreads by the contact of diseased and healthy leaves, especially when agitated by wind. *Solanum* virus II, which is found in the roots of apparently healthy glasshouse plants and does not normally enter the aerial organs, is disseminated in at least two ways. It has been isolated from the sludge in glasshouse tanks and may be introduced to the soil during watering. Experiments with plants grown in air-proof chambers have shown that it also spreads from pot to pot by air-borne particles of infected plant material. This virus and *Nicotiana* virus I have both been recovered from the air one hour after being atomized into it. When the former has been atomized into the air of an air-proof chamber, the plants grown in it under sterile conditions have become infected, while those in an adjacent chamber which was not atomized remained healthy. *Lycopersicum* virus 4 could be recovered from the air only for 5–10 minutes after atomizing, while *Solanum* virus I could not be recovered from the air at all.

The problem of multiplication of adequate stocks of healthy potatoes has occupied Dr. R. N. Salaman's attention for many years. At present, only a third of the potato acreage in England is planted with approximately clean seed, and this leads to a reduction in actual yield, as compared with possible, of some two tons per acre for the

remaining two thirds. Future policy in regard to the potato crop should aim at obtaining maximum tonnage per acre by the use of healthy seed and by the suppression of ground-keepers, always a fertile source of virus infection.

In the fight against virus disease the use of carrier varieties is to be deprecated. There is little hope of obtaining in the near future either genetic or acquired immunity to the serious virus diseases, leaf roll and leaf drop streak, and only drastic reorganization of the potato seed trade offers hope of ameliorating the situation. A scheme was outlined by which really virus-free 'seed', available at Cambridge, should be multiplied first in moist, wind-swept areas on the west coasts of Scotland and Ireland, then grown in the present good seed-growing districts and finally distributed to the ware-producing regions of England. This scheme would include perpetual replenishment of the seed stocks from healthy sources and would afford a prospect of ultimately eliminating loss due to virus disease.

The methods of virus purification originally applied to tobacco mosaic have now been extended by Mr. F. C. Bawden and his co-workers to potato virus *X*, tomato bushy stunt and cucumber viruses 3 and 4. In principle they consist in heating the infective sap to 60° C. (which coagulates most of the normal plant proteins) and precipitating the virus protein from the supernatant by addition of ammonium sulphate. Final elimination of host proteins is accomplished by digestion with proteolytic enzymes which do not attack the virus protein. All the above viruses yield nucleoproteins with very uniform analyses. Final proof that these proteins are pure viruses is impossible to obtain at present, but heterogeneity of the purified products cannot be shown by ultracentrifugation or other means. The slight loss of infective power shown by some of them is attributed to aggregation of particles. Thus in the host plant tobacco mosaic probably exists in the form of approximately spherical particles. In the purified protein these aggregate to form long rods, imparting to the solutions optical properties such as anisotropy of flow, commonly associated with crystalline structure. This virus does not crystallize *in vitro*, but the virus of tomato bushy stunt does so in the form of rhombic dodecahedra.

The origin of potato viruses in Great Britain is probably to be sought in their introduction from South America with the ancestors of the domestic potato. In a study of the virus content of fifty-nine cultivated potato varieties from Puño, South Peru, Dr. R. W. G. Dennis has discovered evidence of the presence of viruses resembling British *X*, *F*, *G*, *B*, *C* and leaf roll. Viruses *A* and *Y* have not so far been found in South American material, but there exists in Peruvian potatoes a number of viruses differing from any known in Europe. Only eleven of the varieties studied were found to be healthy. Investigation of the photo-periodic reactions of South Peruvian potatoes shows that there is no reason on that ground for the conclusion that the domestic potato and its viruses could not have been derived from the plateau region of Peru and Bolivia.

Horizons in Animal Production

THE discussion on animal production in Section M (Agriculture) of the British Association at Cambridge on August 23 had one excellent result: it demonstrated very clearly indeed the inseparableness of the three main constituents—animal husbandry (the feeding and management of livestock), animal breeding and disease-control. Gone, it would seem, are the days when the animal nutritionist claimed that feeding was more important than breeding; or the geneticist, that breeding was more important than feeding; or the animal pathologist, that control of disease was a laboratory problem divorced alike from heredity and husbandry. This is not to say that specialists in each of the three fields have, so far, been wasting their time, for there is plenty of evidence to show that in explaining and improving existing practices they have done very necessary work. The animal geneticist, for example, although he has been unable to direct the emergence of strikingly new and improved types of livestock, has been able to interpret the mechanisms of heredity, to define the prerequisites for successful in-breeding and to examine the significance of mutations.

There is, too, the welcome sign that no longer is a specialist in one field prone to dismiss an unsolved problem by deciding that the solution lies in another field; the time has come when further advance can be hoped for only by co-operation and by studying the animal as a creature living in a given environment, and in relation to the demands made in it by society.

The separation of the problems of animal production into those requiring immediate attention and those that can be dealt with only on a long-term basis can easily be made. Into the first category come measures for disease-control and

measures for increasing efficiency of production through improvements in feeding and management already established but not generally adopted. Prof. R. Rae believes that in recent agricultural legislation (the Agricultural Act and the Livestock Industry Act, both of 1937) there exists the machinery for immediate improvement in both spheres if the interpretation of the Acts is courageous and intelligent. This is especially the case where the organization of producers for marketing purposes provides also the organization for stimulating improvement in the quality of the produce. For example, without the Milk Marketing Board, the guaranteed extra payment for milk from herds free from tuberculosis would be impossible. This payment is already acting as a considerable incentive to the eradication of tuberculosis. As Dr. J. Hammond pointed out, it is much wiser to pay producers to improve their business in this way than, as in the past, to allow them to rear diseased stock and to earn compensation by slaughtering it. The question of food supplies for animals in the event of war is also a problem of the present: in this connexion, the newer methods of making silage from our grassland merit attention.

The problem of disseminating the results of research is to-day as important as any problem requiring research. The gap between the enlightened practice of the few and the mediocre practice of the many worries all who observe it. It is admittedly a problem affecting the whole of farming practice and about it Prof. R. G. Stapledon had much to say. An improvement in rural education is of first importance so that farm labour may be recruited from the ranks of the best rather than from those who are left when the brightest have migrated to town jobs. The rural schools recently started in Cambridgeshire and elsewhere aim to solve this problem; and if those leaving school could begin a definite apprenticeship on the land (as suggested by Prof. Rae) the quality of farm labour could be raised to meet the more specialized requirements which it must now fulfil.

For the present, there is hope of improving the efficiency of production by the spread of quite simple schemes (of which the 'food-recording' schemes for pigs and dairy cows are examples) that provide very valuable yard-sticks. The producer is not given an abstract counsel of perfection; he has his enterprise—his herd of pigs or milking cows—carefully costed for him and, with the help of a skilled supervisor, is able to compare his ability as a manager of livestock with that of his neighbours and to discover directions for improvements. Producers grouped into marketing organizations with monopolistic powers are under a moral obligation to the State to make such schemes general.

The material in a paper on animal diseases by Dr. E. L. Taylor provides a convenient bridge for crossing from the problems of immediate importance to those of the future. It illustrates, too, the nature of the new approach. In the past there has been a tendency to study all diseases in a pathological laboratory, but Dr. Taylor defined disease as a "flaw in the environment". Dealing chiefly with the worm parasites (which cause enormous loss and are of special importance to the sheep industry) he showed the close relation between the health of the animal, its environment and its tolerance of parasites. For example, the age of the animal and its plane of nutrition are important factors; young growing sheep do not have the resistance of mature sheep, and undernourished mature sheep quickly lose their tolerance. A sheep may pass as many as 200,000 worm eggs and be in normal health; if its constitution is reduced (for example, by poor nutrition) the number may increase to 9,000,000 per day. The circle is vicious: pastures became infested and all sheep suffer. While in rare cases specific medicines may effect cures for such a 'disease', there is the much simpler and cheaper cure of good husbandry. Improved pastures and rotational grazing provide a better plane of nutrition, and another species of livestock—cattle, for example—not susceptible to sheep parasites can be employed to clear up sheep-grazings.

In human medicine, the part played by improved housing, sanitation and nutrition in eradicating disease is now generally recognized. In animal production it is certain that improved methods of feeding and management will yield comparable results. The hope is real that the new State veterinary service will provide veterinary husbandmen rather than veterinary pathologists.

The futures of animal nutrition and animal genetics are going to be closely related to the prosecution of anatomical and physiological research. Almost all applied problems can be resolved into terms of the anatomy and physiology of relative growth, of reproduction and of endocrinology. It may seem a far cry from these to society's demand for small succulent joints of meat, rashers of bacon with the right proportion of muscle to fat, eggs of satisfactory weight and milk of better quality or to the desire of the producer to breed and feed livestock that will meet these demands and yet remain fit and profitable; but the connexion exists. In the field of meat production, Dr. Hammond has shown the great possibilities of altering the proportions and quality of the carcass by varying the shape of the growth-curve. Even in closely in-bred animals of a pure breed, an

astonishing flexibility in their response to varying planes of nutrition has been demonstrated. This exploitation of the animal as it grows promises great advances over the old methods of measurement of "live-weight gain per unit of food consumed". Prof. F. A. E. Crew maintains that it is this flexibility (or "degree of modifiability" as he calls it) which must be established for our existing breeds and types of livestock before the geneticist can play his full part.

The importance of further research in the physiology of reproduction is emphasized by the incidence of sterility in livestock, much of which is certainly not pathological, and by the economic need of maintaining and increasing fertility. In this field the use of sex hormones is bound to play a large part—Prof. Crew's forecast of the syringe replacing the seasons is apt. The work at Reading on the lactogenic hormones indicates great potentialities in the sphere of milk-production.

The discovery of a new technique is usually of fundamental importance, and that of artificial insemination is no exception. The improvement of the quality of livestock in Great Britain is greatly hampered by the small size of the breeding-units. For example, one half of the quantity of 'wholesale' milk dealt with by the Milk Marketing Board comes from herds containing ten cows or less. The owners of such small herds cannot afford to buy a sire of adequate merit, and in fact the majority use non-pedigree animals. The result is that much of the home-bred stock is unsatisfactory and new stock has to be purchased. This practice, besides being most inefficient, often is responsible for the introduction of disease. Through the development of artificial insemination, there is the prospect that the small herd may benefit from the use of sires at present confined to the larger herds, where their services are far from being fully exploited.

The evolution of breeds of livestock existing to-day has been directed by breeders working closely with a constantly improving environment and to a definite purpose. There is every indication that the process can be continued and accelerated, and that more can participate in it.

JOSEPH EDWARDS.

PRINTED IN GREAT BRITAIN BY FISHER, KNIGHT AND CO., LTD., ST. ALBANS

58 s. with suggested epicentre in Formosa, but no confirmation has yet been obtained.

Prontosil

MESSRS. BAYER PRODUCTS, LTD., Africa House, Kingsway, London, W.C.2, have issued a booklet surveying the chemotherapy of 'Prontosil', the trade name of three varieties of the sulphonamide series of drugs. Prontosil has been found to possess active properties against human infections caused by the bacterial streptococci, and to be of great service in the treatment of puerperal fever and certain forms of blood-poisoning. It also appears to be of service in the treatment of meningitis caused by the meningococcus and in some other infections. The booklet gives a useful summary of the experimental work that has been done on the physiological action of Prontosil, and of its use in treatment. A bibliography of some two hundred of the more important references is appended. Although a trade production, this booklet gives a fair presentation on the subject of 'Prontosil'.

Appointments in the Colonial Service

THE following appointments and promotions have recently been made in the Colonial Service: G. W. Anderson, to be agricultural officer, Kenya; G. K. G. Campbell, to be agricultural officer, Nigeria; L. J. S. Littlejohn, to be botanist and plant pathologist, Cyprus; S. M. McCombe, to be agricultural officer, Uganda; C. W. R. McCreary, to be agricultural officer, Nyasaland; P. R. Stephenson, to be entomologist, Uganda; J. Barker, to be nutritional investigator, Nyasaland; E. Collins, to be Government analyst, Mauritius; J. P. Glasgow, to be field officer, Tsetse Research Department, Tanganyika Territory; R. L. Stafford, to be assistant meteorologist, Nigeria; H. E. B. Williams, to be sleeping sickness control officer, Nigeria; J. A. Fawdry, inspector of mines, Tanganyika Territory, to be chief inspector of mines, Northern Rhodesia; W. G. Beaton, veterinary research officer, to be senior veterinary officer, Nigeria; N. Clarke, veterinary officer, to be senior veterinary officer, Nigeria; R. Dunwoody, veterinary officer, to be senior veterinary officer, Nigeria; A. B. Ackland, chief clerk, Agricultural Department, to be produce inspector, Agricultural Department, Fiji; P. W. Briggs, agricultural officer and ginnery inspector, Tanganyika Territory, to be agricultural officer and ginnery inspector, Uganda; R. W. Hamilton, chief inspector of antiquities, to be director of antiquities, Palestine; W. O. Harvey, game ranger, Tanganyika Territory, to be deputy game warden, Selangor and Negri Sembilan, Federated Malay States; H. L. Manning, assistant agricultural officer, British Honduras, to be plant breeder in charge of the Cotton Experiment Station, St. Vincent (under the Empire Cotton Growing Corporation).

Announcements

As we go to press, confirmation has reached us of an announcement made a few days ago that Dr. S. B. Nicholson, using the 100-inch reflector at Pasadena, has discovered two new satellites of Jupiter. The objects are extremely faint, the estimated magnitude being 19. No particulars are yet available as to their orbits.

PROF. FLORENCE BARBARA SEIBERT, assistant professor of biochemistry, Henry Phipps Institute of the University of Pennsylvania, Philadelphia, has received the Trudeau Medal in recognition of her research on the chemistry of protein molecules derived from the tubercle bacillus. Prof. Seibert is the first woman to receive the Trudeau Medal.

DR. HERMANN FINK, professor of the biochemistry and technology of fermentation in the University of Basle, has been awarded the Scheele Medal of the Stockholm Chemical Society.

DR. HANS HERENSKY of Johannesburg has been given the Leibnitz Gold Medal of the Prussian Academy of Sciences and Dr. Georg von Bekesy of Budapest the Leibnitz Silver Medal.

PROF. H. FRIESER, of Dresden, has become editor of the *Zeitschrift für wissenschaftliche Photographie, Photophysik und Photochemie* published by Joh. Ambr. Barth, of Leipzig, previously edited by him with Prof. Schaum, of Giessen.

A NEO-HIPPOCRATIC CONGRESS will be held in Marseilles on September 29 under the presidency of Dr. Cornil, dean of the faculty of medicine. Further information may be obtained from Dr. Martiny, 10 rue Alfred Roll, Paris.

AN International Balneological Association has recently been founded in Budapest. The first meeting will be held in Germany this year, the next in France in 1940, and the third in Italy in 1942, during the world exhibition.

WE have received vol. 9 of "Studies from the Connaught Laboratories, University of Toronto" (The University of Toronto Press, 1938), edited by the director, Dr. J. G. FitzGerald. In this volume are bound together reprints of fifty papers, published in different journals during 1937, from the Connaught Laboratories and University of Toronto. The papers cover a wide range of subjects, from public health and pathology to biochemistry and physiology. A brief inspection of the volume gives a good idea of the activities of the Toronto School. A list of the papers included is given at the beginning of the volume, but there is no subject or author index, which would add to its value as a work of reference.

ERRATUM. In the letter entitled "Control of Insects by Methallyl Chloride", by Dr. C. J. Briejèr, in NATURE of June 18, p. 1099, the third line under the formula: "Mixtures of its vapour with air are not explosive in concentrations of 105–339 gm. per cub. m.", should read, "Mixtures of its vapour with air are explosive in concentrations of 105–339 gm. per cub. m."

Letters to the Editor

The Editor does not hold himself responsible for opinions expressed by his correspondents. He cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 540.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

The Law of Error

DR. J. NEYMAN, in his review[1] of Karl Pearson's "Grammar of Science", which was republished on my suggestion, quotes a passage from my recent paper[2] on the law of errors as "a remarkable illustration of the confusion of the perceptual and the conceptual spheres of thought". The whole of my work on probability is based on the recognition of the distinction between description and inference, the neglect of which is responsible for much confusion in current statistical and physical theory. Inference, in my opinion, begins at an even earlier stage than Pearson states in the "Grammar". In the passage quoted it should be clear that I am speaking wholly in the inferential sphere. An actual set of observations is necessarily discrete and cannot be described by any continuous law of error. But it may provide means of saying which of several continuous laws is the more probable on the data.

Dr. Neyman says that observations are irrelevant to the truth of a mathematical theorem. I agree. But a theorem that rests on the postulate that an error is the resultant of many comparable and independent components is not wholly mathematical, and can apply only to errors that do satisfy those conditions, and the observed distribution of errors is relevant to whether those conditions are satisfied. For this reason I think that many elaborate experimental investigations to test, for example, the binomial and χ^2 distributions, are misinterpreted. They do not test whether the distributions would hold in the conditions postulated in their proofs; they test whether those conditions have been satisfied in the design of the experiment. But in the case of the mathematical 'proof' of the normal law of error, it is not shown, or even true, that the law holds for all possible errors *even if the conditions postulated in the proof are satisfied.*

On the other hand, the law of error, whatever it is, is a description of a distribution of chance, not of any set of observational facts. It is the exception, not the rule, for a set of observations to be sufficiently numerous even to distinguish between the normal and triangular distributions of chance, and if any law is asserted from some set that is sufficiently numerous, and then the method of combining the data that it implies is applied to another set that is not sufficiently numerous, inductive inference is used. So also is the hypothesis that the actual discrete observations have been derived from *some* continuous law of chance, and that the discreteness is due only to the fact that the number of observations is finite.

Considering that I have been insisting on the distinction between description and inference for nearly twenty years, I think that I might have been spared the accusation of confusing them.

I think that the time has come also for a protest against the statement that continues to be made in statistical writings that a prior probability is a frequency. So far as I am aware, the principle of inverse probability was stated by Bayes eighty years before the first statements of any frequency definition, by Leslie Ellis and Cournot. A frequency definition was certainly not used by Bayes or Laplace, and Wrinch and I showed in 1919 that it would not suffice as a basis even for direct methods. What is done in direct methods is that an inference from a hypothesis to the observations (which can be made on the hypothesis that chances exist, without the circumlocution of a frequency definition to provide an unsatisfactory justification) is converted at the end by a verbal argument into an inference from the observations to the hypothesis; what the principle of inverse probability does is to replace this verbal argument by a symbolic statement. To convert either into a prediction of a long run frequency involves a use of Bernoulli's theorem, the conditions for the applicability of which need very careful statement, which they scarcely ever receive.

HAROLD JEFFREYS.

St. John's College,
Cambridge.

[1] NATURE, **142**, 229 (1938).
[2] *Phil. Trans. Roy. Soc.*, A, **237**, 231-271 (1938).

Effects of Be-D Radiations upon *Vicia Faba*

THE retarding action of neutron rays upon the roots of wheat seedlings has been reported by R. E. Zirkle, P. C. Aebersold and E. R. Dempster[1], and recently by R. E. Zirkle and I. Lampe[2], but the daily growth of individual seedlings after irradiation has not been reported yet. In the present experiments, the lengths of individual roots of *Vicia Faba*, which were exposed to radiations produced by bombarding a beryllium target with 2·8 Mev. deuterons from the cyclotron of this laboratory, were measured day by day after the exposure.

Three days before irradiation, the seeds were submerged in distilled water for one day and then planted in sawdust saturated with sterilized tap-water, in a dark thermostat at 30° C., where they were allowed to remain exactly for two days before irradiation. Then, only those individuals the primary roots of which were from 15 mm. to 25 mm. long were selected for the experiments. For irradiation, two of these seedlings were planted in a small glass box filled with sawdust, and were placed in the dark observation chamber of the cyclotron, where they were exposed to the beryllium-deuteron radiation for one hour at a distance of 6·5 cm. from the beryllium target, the deuteron current being 10 microamperes. During the same period two more seedlings, planted in another glass box, were placed for control in a dark chamber which was kept distant

from the cyclotron. After the exposure, the irradiated seedlings together with the controls were put on a wooden plate, floating on tap-water in a two-litre glass beaker, and their roots were placed separately in glass tubes, which were hanging down from the plate into the water. The beaker was kept in the dark thermostat at 30° C., and the lengths of the main roots were measured every 24 hours after the exposure.

The average growths in length of the main roots of fifty irradiated seedlings during the intervals of 24, 48, 72 and 96 hours respectively after the beginning of irradiation, are given in the second row (*R*) of the accompanying table, and σ is the standard error of mean. For comparison, the corresponding data of fifty non-irradiated controls are given in the third row (*C*) of the same table. From the standard errors obtained, we can see a clear retardation of growth even in 24 hours after irradiation. The ratio *R*/*C* decreases with the lapse of time after the exposure, and becomes 46 per cent after a period of 92 hours. Further, we found that side roots never appeared in the irradiated specimens within 4 days, while in controls 94 per cent of the individuals have sprouted lateral roots by this time.

Period after radiation	24 hr.	48 hr.	72 hr.	96 hr.
R (length in mm.)	16·7 ($\sigma = 0·8$)	22·7 ($\sigma = 1·0$)	24·5 ($\sigma = 1·2$)	24·7 ($\sigma = 1·0$)
C (length in mm.)	23·7 ($\sigma = 0·8$)	39·5 ($\sigma = 1·0$)	48·9 ($\sigma = 1·3$)	52·9 ($\sigma = 1·4$)
R/*C* (per cent)	70·4	57·4	50·3	46·9

While we were carrying out these experiments, retarding actions of X-rays upon the main root of the same species were determined, in exactly the same manner, by Misses M. Sudô and S. Imai in the laboratory of one of us (M. N.). According to their experiments, the ratio *R*/*C* at an interval of 4 days after one hour irradiation with X-rays (160 kv., 0·5 mm. Cu, 0·5 mm. Al) for calculated doses of 200 r., 300 r. and 400 r. are 59, 52 and 40 per cent respectively. The intensity of our beryllium-deuteron radiations under the present conditions thus corresponds to about 6 r./min. of X-rays when measured by the retarding action in 4 days after the exposure on the main root of *Vicia Faba*.

In conclusion, our thanks are due to Prof. S. Nishikawa, Dr. Y. Nishina and other members of the Nishikawa laboratory as well as of this laboratory for their kind suggestions and valuable assistance, especially in connexion with the operation of the cyclotron. We wish to thank the Japan Wireless Telegraph Company for the electromagnet and other equipment used for the cyclotron, and the Mitsui Ho-onkwai Foundation, Tokyo Electric Light Company and Tôsyogû Tercentenary Memorial Endowment for financial support.

MASANORI NAKAIDZUMI.
KÔITI MURATI.

Nuclear Research Laboratory,
Institute of Physical and
Chemical Research,
Tokyo.
July 13.

Zirkle, R. E., Aebersold, P. C., and Dempster, E. R., *Amer. J. Cancer*, **29**, 556 (1937).
Zirkle, E. R., and Lampe, I., *Amer. J. Roent.*, **39**, 613 (1938).

Pure Stark Effect observed in Metallic Arcs

IT has been generally accepted that in an arc the observation of the pure Stark effect can scarcely be expected, as the drop in potential in the immediate neighbourhood of the electrodes is of the order of the ionization potential of the gas, and the dark space is so thin (10^{-3} cm. or less) that its detection is extremely difficult; the uncontrollable fluctuation of the arc and the effects due to pressure and inter-ionic fields may give rise to further complexities, which manifest themselves in the anomalous behaviour (diffuse broadening or shift) of spectral lines.

Terminal potential diff., 48 volts; current, 2·13 amp.; arc length, 3·5 mm.

In spite of these expectations, we have now succeeded, by proper choice of arcing conditions, in observing the pure Stark effect for a number of lines of iron, copper, silver, nickel and aluminium, most of which belong to the spark type. An enlarged reproduction of a small segment of the spectrogram of silver is given in the accompanying illustration.

Important points to be noted, as the results of the present investigation, are (1) that in a steady metallic arc there can exist at least two regions *s*, where the field intensity is so great that the pure Stark effect can be observed, namely, at a certain distance (*c.* 1·5 mm.) from the lower (positive or negative) electrode and in the immediate neighbourhood of the upper electrode; (2) that there are fairly large drops of potential occurring in *two* steps at *each* electrode, the indication of which is the appearance of the spark lines, and so there are three points along the arc where the field intensity becomes a minimum—at two regions *d* about 0·8 mm. distant from the electrodes and at the centre *g* of the arc; (3) that, when the pressure is reduced, no essential change is produced in the potential distribution along the arc; (4) that, as the length of the arc is varied, the length of the region *g* changes linearly with it, while the behaviour of the lines near the electrodes remains the same.

JIRO HURUITI.
TAKEO HORI.

Physical Laboratory,
Hokkaido Imperial University,
Sapporo.

An Application of a New Limitation in Physical Theory

IN attempts to understand the relation between the quantum theory and the theories of relativity and electro-magnetism, a certain limitation, applicable to the motion of a particle of electromagnetic mass m_0 and of charge e, is brought to light. It appears that the expression $(m_0c^2d\tau - e/c\Sigma\varphi_m dx^m)$ can assume only those values which are multiples of Planck's constant[1].

$d\tau$ is an element of proper time associated with the track of the particle, dx^m is a component of displacement and φ_m is a component of electromagnetic potential. An interesting result is obtained if this be applied to an electron in an electrostatic field of potential Ne/r. This is the case with an electron in an atomic orbit where N is the number of the atom. The above condition then implies $(m_e c^2\sqrt{1-\beta^2} - Ne^2/r)\,dt \not< h$ where $\beta = v/c$, v being the velocity of the particle, and where account is taken of the fact that the nuclear and electronic charges are of opposite sign. If we consider the case of the K-level of an atom and make use of Sommerfeld's value for Ne^2/r, which may be regarded as a sufficient approximation, we obtain $m_e c^2\,(\sqrt{1-\beta^2} - \beta^2/\sqrt{1-\beta^2})\,dt \not< h$. In this case $\beta = N\alpha$, where α is the fine-structure constant $2\pi e^2/hc$. We note that as β approaches the value $1/\sqrt{2}$ the factor of dt approaches zero very rapidly, and the limitation states that the least possible value of dt is very large. We interpret this as an indication of the breakdown of the description of the charge as a particle in motion. This gives a clue to the nature of the limitation. It provides us at each point of space and time with a criterion for the dynamical description of an electric charge.

In this particular example the limitation is interpreted to mean that the K-level does not exist when $\beta = N\alpha \gg 1/\sqrt{2}$.

The condition appears to be similar to a condition of stability, the K-ring at a certain point becoming completely unstable.

The value of N which results from this equation is very close to 97, and we conclude that atoms with numbers up to 96 may possess a complete set of energy levels beginning with the K-level. Beyond this, K-levels do not exist and nuclei of a larger number would possess energy layers beginning at a higher level[2].

The condition $\beta \gtrsim 1/\sqrt{2}$ can be expressed by stating that electrons in atomic orbits have de Broglie wave-lengths greater than $h/m_e c$. It is interesting to note in conclusion that in the example considered we find another relation involving the fine-structure constant to add to the considerable number already known.

H. T. FLINT.

Wheatstone Laboratory,
King's College,
London, W.C.2.
July 30.

[1] Flint, *Proc. Roy. Soc.*, A, **159**, 45 (1937).
[2] Flint and Richardson, *Proc. Roy. Soc.*, A, **117**, 637 (1928).

Ultra-Violet Band System of Silicon Monotelluride

FOLLOWING up the recent observations of ultra-violet band systems of SiS[1] and SiSe[2] in heavy-current discharges through silica tubes containing aluminium sulphide and aluminium selenide respectively, I have now applied an analogous method for the development of the corresponding system of SiTe. In this case, a 2·5-amp. A.C. discharge has been passed through a powdered mixture of aluminium and tellurium in a silica tube. The system lies between λ 3307 and λ 3831, having its $0 \rightarrow 0$ band at λ 3496·4.

As guides to the identification of the SiTe system there are not only the progressive changes in the system-origins and vibrational coefficients of SiO, SiS and SiSe, but also the data for the corresponding system, B $\leftarrow$ X, of SnS, which has the same number of electrons (66) as SiTe. There is, indeed, a remarkable similarity between the expressions for these two systems, just as there is between those for the corresponding systems of the lighter isoelectronic pair, GeS and SiSe (48 electrons), thus:

$$\left.\begin{aligned} {}^{\nu}_{GeS} &= 32889{\cdot}5 + (375{\cdot}0\,u' - 1{\cdot}51\,u'^2) - (575{\cdot}8\,u'' - 1{\cdot}80\,u''^2), \\ {}^{\nu}_{SiSe} &= 32448{\cdot}7 + (404{\cdot}3\,u' - 3{\cdot}24\,u'^2) - (580{\cdot}0\,u'' - 1{\cdot}78\,u''^2), \end{aligned}\right\}$$

$$\left.\begin{aligned} {}^{\nu}_{SnS} &= 28337{\cdot}9 + (331{\cdot}9\,u' - 1{\cdot}25\,u'^2) - (487{\cdot}7\,u'' - 1{\cdot}34\,u''^2) \\ {}^{\nu}_{SiTe} &= 28665{\cdot}9 + (333{\cdot}4\,u' - 0{\cdot}54\,u'^2 - 0{\cdot}05\,u'^3) - (480{\cdot}7\,u'' - 1{\cdot}30\,u''^2) \end{aligned}\right\}$$

where, as usual, u stands for $v + \frac{1}{2}$.

The values of $I_M I_X/E_e$ and ω_e'/ω_e'' for SiTe are 20·6 and 0·694 respectively, which are of the same orders of magnitude as those previously found for SiS and SiSe. The ratio (ω_e of SiTe)/(ω_e of SiSe) takes the values 0·824 and 0·829 for the excited and ground states respectively. As expected, these are greater than those for (ω_e of SiSe)/(ω_e of SiS), namely, 0·790 and 0·774, respectively, which, again, are greater than those for (ω_e of SiS)/(ω_e of SiO), namely, 0·602 and 0·604 respectively. A similar change is found[3] in the corresponding ratios of coefficients in the case of PbTe, PbSe, PbS and PbO.

R. F. BARROW.

Imperial College,
London, S.W.7.
Aug. 8.

[1] Barrow, R. F., and Jevons, W., NATURE, **141**, 833 (1938).
[2] Barrow, R. F., NATURE, **142** [434] (1938).
[3] Barrow, R. F., and Jevons, W., forthcoming paper.

Band Spectrum of Helium

WHEN helium at a pressure of about 25 mm. of mercury is excited in such a way as to produce the line spectrum and the band spectrum in comparable intensity, McCallum and Wills[1] find that the band spectrum persists much longer than the line spectrum after the excitation is removed. They show a spectrogram of the discharge, taken 1/600 sec. after the discharge had been interrupted, in which the line spectrum has disappeared while the band spectrum is still of approximately the same intensity as that from the discharge before interruption.

From this persistence of the band spectrum McCallum and Wills infer that either the helium molecules formed in the discharge have a life of the order of 1/600 sec. or, more probably, they are formed after interruption of the discharge by the collision of a metastable atom with a neutral atom.

That the latter inference is correct is shown by the recent work of Arnot and M'Ewen[2], who have investigated the formation of helium molecules by the balanced space-charge method, and have shown that the helium molecule is formed in the ionized state by the attachment of a metastable atom in the $1s2s$, ^3S state of 19·77 volts energy to a normal atom. This paper was published after McCallum and Wills's letter was communicated.

F. L. ARNOT.

University,
St. Andrews.
Aug. 18.

[1] McCallum, S. P., and Wills, M. S., NATURE, **142**, 252 (1938).
[2] Arnot, F. L., and M'Ewen, M. B., *Proc. Roy. Soc.*, A, **166**, 543 (1938).

Fundamental Physical Structure

THE suggestion by Dr. Drysdale, in NATURE of August 13, that by resorting to the experiments and equations of Ampère relating to the forces between current-carrying conductors, magnetism may be eliminated from fundamental physical concepts, reminds me that in the course of conversation with the late Sir Horace Lamb some years ago, he remarked that it would greatly simplify mathematical treatment if we could dispense with the duality of electricity and magnetism and concentrate on one of them, as Ampère appeared to have done. The hint was the more impressive because Sir Horace, in his "Hydrodynamics", had set forth the vortex theory so convincingly.

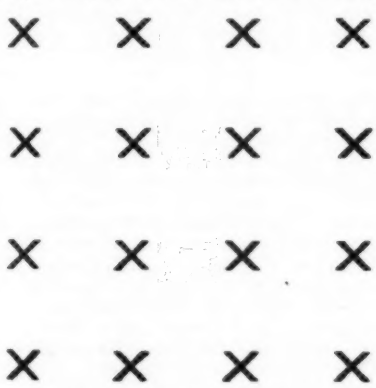
What Dr. Drysdale now does is to substitute the force corresponding to the product of charge and velocity of a proton or electron, for Ampère's current-element force, thus eliminating the magnetic link. It is difficult to dissociate permeability from what Dr. Drysdale designates "magnetic considerations", but presumably it would take its place as a general variable in the concept.

80 St. Mary's Mansions, ROLLO APPLEYARD.
London, W.2.

A Binocular Illusion

I WAS much interested in Sir Richard Paget's letter in NATURE of July 9, as I have observed the converse effect, in which a 'suspended image' may be seen *behind* the pattern viewed.

The effect may be obtained by drawing a simple pattern (for example, of crosses, as in the enclosed sketch) enlarged so as to give a suitable interval between the elements: this is rather less than the distance between the eyes (in my case, two inches for an eye interval of two and a half inches). The



pattern is held at a suitable distance—about twelve inches—and the eyes relaxed: having persuaded the blurred images to coincide so that one element is superposed on its neighbour's image, the eyes are focused *without* losing this superposition, that is, without turning them inwards to their original position. The illusion of a magnified image behind the object is assisted if the eyes are permitted to move over the pattern or blinked, or if the pattern is moved slowly towards and away from the observer.

A chessboard held diagonally is a suitable pattern, but the illusion is much more striking with an object such as wire netting, and I have found a window pane of frosted glass with a pattern of stellate clear patches (at the appropriate interval) very effective indeed: the most favourable conditions, however, require a little practice and patience.

The optics of this phenomenon are of course similar to those of Sir Richard's version. The eyes are focused for an object at a certain distance, but the angle subtended by their respective lines of sight is appropriate to an object at a greater distance.

J. D. MORTON.
Officers' Mess,
Experimental Station,
Porton, Wilts.
Aug. 1.

Antarctica and Glacial Ages

As geologist to the British Graham Land Expedition, I should like to direct attention to certain mis-statements which appear in Prof. E. W. MacBride's recent article[1] concerning the geological discoveries which our expedition made in the Antarctic.

Prof. MacBride states: "The part [of Antarctica] so far principally studied is that directly south of South America, in which lies the inlet known as the Ross Sea". A glance at the map will show that the Ross Sea is some 100°–120° of longitude west of South America. Our expedition was working in what is commonly referred to as the West Antarctic, which is south of South America but very many miles from the Ross Sea. Further, Prof. MacBride states that we collected from the Beardmore glacier erratic rocks "of the Gondwana age, with coal-seams carrying characteristic fern plants". He probably has in mind the Permo-Carboniferous plant remains which were collected by Captain Scott's polar party from the region of the Beardmore Glacier, and which were described by Sir Albert Seward. The Beardmore Glacier is nearly 2,000 miles from the region we visited. The only plant-bearing deposits we found were from the eastern shore of Alexander the First Land, and are probably Middle Jurassic but certainly not Permo-Carboniferous or "Gondwana" in age. As a result of Prof. MacBride's mis-statements it is difficult to understand what geographical relation he assumes the Antarctic Permo-Carboniferous deposits bear to the presumed continent of Gondwanaland. Consequently it is doubtful how far the arguments which he bases on their distribution may be regarded as relevant.

Prof. MacBride states that Antarctica entirely escaped the "Gondwana ice-age", but since no rocks of Permo-Carboniferous or "Gondwana" age have yet been found in West Antarctica (which, it should be remembered, is markedly dissimilar from the region round the Ross Sea both as regards the geological formations that occur and their tectonic structure), no certain conclusions can be drawn as to the climate of this part of the continent in "Gondwana" times.

In recent years many lines of evidence have accumulated to suggest that during past geological ages various parts of the earth's crust drifted relative to one another and to the axis of the earth. The wide-spread distribution of a characteristic Permo-Carboniferous flora throughout many lands, which are now widely separated, is of particular significance. There is also evidence to show, as Prof. MacBride points out, that drifting may still be going on at the present day, at all events in certain parts of the world. It is hard to escape the conclusion that continental drift is one important contributory cause

of the Permo-Carboniferous and other pre-Pleistocene glacial epochs, but to claim, as Prof. MacBride does, that "drift into high latitudes affords a complete explanation of all glacial phenomena previous to the Pleistocene" is surely to propose a too facile solution for a highly complicated group of problems which further information can alone clarify.

W. L. S. FLEMING.

Trinity Hall,
Cambridge.
July 28.

[1] NATURE, **142**, 97–99 (July 16, 1938).

IN answer to the criticisms of the Rev. W. L. S. Fleming, I have frankly to admit two foolish mistakes in nomenclature. For "Ross Sea" read "Weddell Sea," and the height of land from which the Beardmore Glacier takes its origin is of course a few projecting peaks which are *not* Erebus and Terror.

The mistakes in nomenclature leave my argument quite unaffected: indeed, since then I have measured on *The Times* map the actual breadth of the ice-shelf. If, as Dr. Stephenson assures me, the Beardmore Glacier is 200 miles long, the breadth of ice-shelf to be added is 1,200 miles. This gives 1,400 miles as the length of the ice-flow, and nothing in the Pleistocene ice-flows approached this.

With regard to the fossils from the rocks beneath the ice-sheet, I thought that all knowledge of these was gathered from the erratics which Scott brought back. I am delighted to learn that Jurassic strata are exposed in one place and that these show no signs of glaciation. It is of course conceivable that, while one part of Gondwanaland escaped Gondwana glaciation, another part did not do so—but this is not a likely supposition.

My conception of the Gondwana ice-age is as follows. In Permo-Carboniferous times there was one huge southern continent, lying in temperate regions to the north and east of the South Pole. In this continent there was a characteristic flora which enables portions of it to be recognized wherever they are.

In Permo-Carboniferous times it drifted southward over the pole. At that time Australia and Antarctica lay at its northern edge. As the drift continued, both Australia and Antarctica broke off and remained in the temperate zone. The rest of the continent as it reached the pole underwent severe glaciation, after which in Cretaceous times it broke into three great fragments, namely, South America, South Africa, the Deccan of India, in all of which traces of this ice-age can be seen. Sir Thomas Holland has said that these traces can be detected in portions of the north of India, so far did the drift go on. At a later period the same drift affected Antarctica and led, as I said, to its present condition.

Mr. Fleming, while agreeing generally with the theory of continental drift, says that it is a rash thing to make it account for all the ice-ages. It certainly does not account for the Pleistocene ice-age, as I said. But besides the Pleistocene there are only two well-authenticated ice-ages in the history of the earth, the Pre-Cambrian and the Gondwana. So far as I can find out, there are no traces of the Pre-Cambrian ice-age in the southern hemisphere. Beds supposed to belong to this ice-age in India have been recently shown to be relics of the Gondwana ice-age.

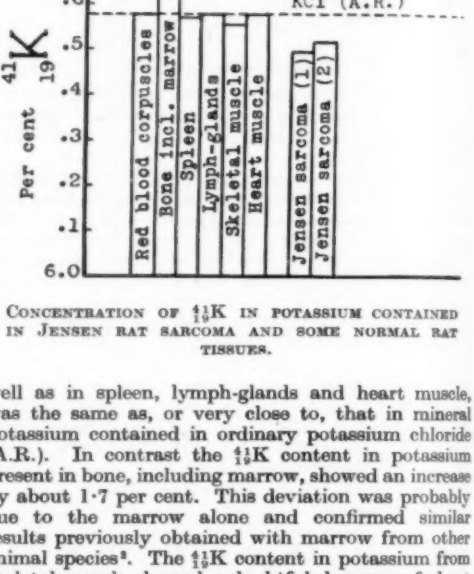
E. W. MACBRIDE.

West Bank,
Alton,
Hants.

Isotopic Constitution of Potassium in Normal and Tumour Tissue

WITH the idea that the isotopic constitution of potassium contained in tumour tissue might be somewhat different from that present in normal tissue, comparative investigations in this field have been undertaken. The abundance ratio $^{39}_{19}K/^{41}_{19}K$, and thereby, practically, the concentration of the heavy isotope $^{41}_{19}K$, was estimated in potassium present in the ashes of various kinds of normal and tumour tissue, the measurements being carried out by means of a mass-spectrograph previously described in detail[1,2].

A selection of the results so far obtained is illustrated in the accompanying figure, showing the percentage of $^{41}_{19}K$ in potassium contained in Jensen rat sarcoma and in some normal rat tissues of mesodermal and mesochymal origin, including red blood corpuscles. It will be seen that the content of $^{41}_{19}K$ in potassium present in red blood corpuscles, as



CONCENTRATION OF $^{41}_{19}K$ IN POTASSIUM CONTAINED IN JENSEN RAT SARCOMA AND SOME NORMAL RAT TISSUES.

well as in spleen, lymph-glands and heart muscle, was the same as, or very close to, that in mineral potassium contained in ordinary potassium chloride (A.R.). In contrast the $^{41}_{19}K$ content in potassium present in bone, including marrow, showed an increase by about 1·7 per cent. This deviation was probably due to the marrow alone and confirmed similar results previously obtained with marrow from other animal species[2]. The $^{41}_{19}K$ content in potassium from skeletal muscle showed a doubtful decrease of about 0·4 per cent. Ashes for these determinations were prepared from mixed tissues taken from an equal number of males and females. The average animal weight, corresponding to each tissue, was between 210 gm. and 225 gm.

In comparison with the above results it was found that the relative $^{41}_{19}K$ content in Jensen rat sarcoma was distinctly low. Two samples of ash from tumours obtained by subcutaneous inoculation are here considered. The tumours constituting sample (1) had an average weight of about 15 gm. and were taken, 18 days after inoculation, from animals having an average weight similar to those considered above; the tumours constituting sample (2) had an average weight of about 14 gm. and were taken, 14 days after inoculation, from animals having a much lower average weight. The potassium in sample (1) contained about 1·3 per cent and that in sample (2)

about 1·0 per cent less $\frac{41}{39}$K than mineral potassium. Both living and necrotic parts of tumour were utilized in the preparation of these samples, but two other samples prepared from only living parts showed approximately the same percentage.

Similar slight deviations were obtained in potassium from mouse sarcoma 37 S and from some forms of human cancer tissue; so far no corresponding normal tissue has been taken for comparison, except human bone marrow, which gave results similar to rat bone marrow.

Detailed accounts of our investigations will appear elsewhere.

A. LASNITZKI.

Cancer Research Department,
University, Manchester.

A. K. BREWER.

Bureau of Chemistry and Soils,
U.S. Department of Agriculture,
Washington, D.C.
Aug. 8.

Brewer, A. K., *J. Amer. Chem. Soc.*, **58**, 365 (1936).
Brewer, A. K., *J. Amer. Chem. Soc.*, **59**, 869 (1937).

Active Group of Papain

FROM their work on the active group of papain, Bersin[1] and Purr[2] concluded that the SH group was essential for the hydrolysis of gelatin by the enzyme, the activity disappearing with the oxidation of the SH to the SS form.

We have already shown that the papaya latex is rich in SH compounds (about 2 per cent) and that about a tenth of it is glutathione[3]. This observation led us to the examination of the activation of papain.

An aqueous extract of the fresh latex, previously extracted with ether, was treated with hydrogen peroxide to oxidize all the SH to the SS as shown by the nitroprusside test, and then precipitated with alcohol, washed with absolute alcohol and dried in vacuum. This preparation, while being completely inactive towards peptone, retained its capacity to hydrolyse gelatin. Its 'gelatinase' activity was comparable to that of the preparation activated by hydrogen cyanide or glutathione. Its optimum *p*H was in the neighbourhood of 3, far below the value (4·6–5·0) reported in the literature for papain. The reaction mixture before and after incubation did not answer the nitroprusside test. The results obtained are tabulated below.

(250 mgm. gelatin or peptone + 250 mgm. of SS prepn. in 20 c.c. of buffered solution, *p*H 3. Temp. 38° C. Time of incubation, 20 hr. The activity is measured by the increase in formol titration of 2 c.c. of the reaction mixture against 0·1 *N* caustic soda.)

		Gelatin	Peptone
1.	SS preparation in citrate buffer	0·25	0·00
2.	,, in acetate buffer	0·27	0·01
3.	,, +hydrogen cyanide	0·38	0·30
4.	,, +glutathione	0·48	0·46
5.	,, +maleic acid	0·26	0·00
6.	,, +iodoacetic acid	0·00	0·00

Maleic acid, which has recently been shown to inhibit the activity of enzymes the activity of which depends on the presence of the SH group[4], is without effect on the gelatinase activity of the preparation. Iodoacetic acid inhibits the activity irreversibly.

These results indicate that for the gelatinase activity of papain the SH group is not necessary; other groups which react irreversibly with iodoacetic acid appear to be essential. At the same time, it is evident that the SH group is essential for 'peptonase' activity.

We have also got evidence that the papain hydrolysis of the protein takes place in two definite stages, first to peptone and then to simpler amino acids; the activation mechanism being specific for the two stages.

C. V. GANAPATHY.
B. N. SASTRI.

Department of Biochemistry,
Indian Institute of Science,
Bangalore.
July 29.

[1] Bersin, *Hoppe-Seyl. Z.*, **222**, 177 (1933).
[2] Purr, *Biochem. J.*, **29**, 5 (1935).
[3] Ganapathy and Sastri, *Curr. Sci.*, **6**, 330 (1938).
[4] Morgan and Friedmann, *Biochem. J.*, **32**, 862 (1938).

Excretion from Leguminous Root Nodules

IN previous communications[1,2,3], I have reported my inability to detect appreciable excretion of nitrogenous substances from root nodules of leguminous plants, and thus to confirm the results obtained by Virtanen. During the past summer, further trials have been carried out with soya bean (4 varieties), pea (5 varieties), and broad bean. Three rooting media have been employed, namely, (*a*) a coarse quartz sand composed of particles of diameter mostly in the region of 0·5 mm.; (*b*) a fine quartz sand of particles diameter 0·1–0·3 mm.; and (*c*) a very fine quarry sand of particles 0·1 mm. and less. (*b*) appears to be very similar to the sand used by Virtanen. Open and closed containers have been used, while the tests for excretion consisted of analysis of rooting medium and of barley plants grown in association with the legumes.

Satisfactory growth and fixation were shown by the legumes, but in no instance was evidence of excretion obtained. The pea varieties included Torstai and Concordia, inoculated with bacillus strain *HX*, combinations which in Virtanen's experiments gave vigorous excretion. I have repeated Virtanen's arrangements and conditions so far as is practicable, and yet have obtained very different results. It is clear that apart from the possible influence of factors such as identity of legume, bacterial strain and adsorptive capacity of rooting medium, some other factor has a controlling effect on excretion. Wilson and his collaborators[4,5], recently reached a similar conclusion from their Wisconsin experiments, and advanced evidence that excretion depends on the maintenance of a certain relation between rate of photosynthesis and of fixation, and for this reason is liable to be affected by light intensity and temperature. These factors were not subject to close control in my experiments. The soya beans were grown in a lean-to greenhouse partly shaded by trees, with a day temperature of 65–75° F. The other legumes were placed outside on dry days in a position where they received a maximum of six hours sunshine daily. No difference in excretion has emerged in these experiments between soya bean and the so-called 'cool weather' legumes, negative results having been obtained in all cases.

G. BOND.

Department of Botany,
University,
Glasgow. Aug. 25.

[1] Bond, NATURE, **139**, 675 (1937).
[2] Bond, NATURE, **140**, 683 (1937).
[3] Bond, *Ann. Bot.* (N.S.), **2** (1938).
[4] Wilson and Burton, *J. Agric. Sci.*, **28**, 307 (1938).
[5] Wilson and Wyss, *Proc. Soil Sci. Soc.*, 289 (1937).

The Mexican Loggerhead Turtle in Europe

THE Mexican loggerhead turtle, *Colpochelys kempi* Garman, is distinguished from *Caretta caretta* (Linné) by its colour, in possessing four enlarged inframarginals instead of three on each side, and its smaller size. A native of the Gulf of Mexico and adjacent waters, it is so localized that few if any European museums possess specimens. Hence its appearance off the west coast of Ireland is of unusual interest.

Two specimens so obtained in 1928 and 1934 are now in the National Museum at Dublin and are No. 92—1928 and No. 108—1934 respectively. The straight carapace length of the former is 256 mm., of the latter 245 mm. These will be dealt with more fully by me in the *Irish Naturalists' Journal*.

The presence of *Colpochelys kempi* in these waters suggests that the common *Caretta caretta* which appears off Ireland is also derived from American waters, and not from the neighbouring south European seas. This opinion is further supported by a *Caretta caretta* in the Whitby Museum with the label "Washed aboard ss. *Ethelfreda* North Atlantic 1926".

It is thus very probable that the presence of *Caretta caretta* (Linné) in European waters is mainly if not entirely due to currents, for no definite breeding grounds exist on the European coast as on the American side of the Atlantic.

The possibilities of sea turtles as current indicators would thus appear to be considerable, and it is to be hoped that their importance in this respect will receive due recognition.

P. E. P. DERANIYAGALA.

Linnean Society,
London, W.1.
Aug. 24.

Visual Image Produced by a Photoflash Bulb

A LUMINOUS visual image, very closely resembling some 'ball lightning' observed at high altitudes, may be produced by the firing, without warning, of a photoflash bulb just beyond the limit of an observer's normal field of vision.

The optical illusion produced will be described by the observer as a greenish or reddish ball that wandered into his field of vision from the side, became smaller and changed colour near its centre ("right in front") and finally faded and vanished. No two persons will give identical reports.

From the foregoing, it is suggested that certain (not all) reports of 'ball lightning' are actually descriptions of an optical illusion (probably a sort of after-image) produced by a brilliant lightning flash somewhere just outside the observer's visual field.

RONALD L. IVES.

1129 13th Street,
Boulder, Colorado.

Points from Foregoing Letters

COMMENTING on Dr. Neyman's remarks in a recent review of Pearson's "Grammar of Science", Dr. Harold Jeffreys states that the law of errors is a description of a distribution of chance, not of observational facts. It does not hold for all possible errors, even if the conditions postulated in the proof are satisfied. He also points out that the principle of 'inverse probability' was stated long before any 'frequency' definition.

An appreciable retardation in the growth of the roots of broad bean seedlings, after exposure in a cyclotron chamber to radiations from a beryllium target bombarded with a deuteron current of 10 microamperes, is reported by Prof. M. Nakaidzumi and K. Murati.

An enlarged reproduction of the lines 2317 and 2321 A. in the arc spectrum of silver, obtained under special arcing conditions, and showing splitting due to the electric field (Stark effect) is submitted by Dr. J. Huruiti and Prof. T. Hori. Their investigation throws light on the distribution of the potential drop and field intensity within the arc.

By applying a new limitation, arising from quantum-relativity relations, to an electron moving orbitally in an electrostatic field, Dr. H. T. Flint obtains a condition of stability which indicates that in atoms with atomic numbers larger than 96 the *K*-level cannot exist.

R. F. Barrow reports the observation and vibrational analysis of the ultra-violet band system of SiTe corresponding to the SiSe, SiS and SiO systems already described by him and Dr. W. Jevons.

A binocular illusion in which a regular pattern, by suitable adjusting, appears enlarged and suspended behind the actual pattern, is described by J. D. Morton.

The Rev. W. L. S. Fleming corrects certain points to which Prof. MacBride referred in his article on "Antarctica and Glacial Ages" concerning the British Graham Land Expedition's geological discoveries. No rocks of "Gondwana" age have yet been found in West Antarctica and there is no evidence as to what climate this part of the world experienced during the "Gondwana ice-age". Existing evidence does not justify the conclusion that continental drift affords a complete explanation of all pre-Pleistocene glacial phenomena. Prof. E. W. MacBride admits two errors in nomenclature, but claims that by substituting "Weddell Sea" for "Ross Sea", the argument is unaffected.

The isotopic constitution of potassium contained in tumour tissue and normal tissue, mainly from the rat, has been studied by Dr. A. Lasnitzki and Dr. A. K. Brewer. Distinct, although slight, deviations from the norm were obtained with the potassium present in tumour tissue and bone marrow. The percentage of $^{41}_{19}K$ was decreased in the former case, increased in the latter.

C. V. Ganapathy and B. N. Sastri state that if the sulphydril group SH of the enzyme papain is oxidized by hydrogen peroxide, the enzyme loses its power to act upon peptone, but retains its hydrolysing power on gelatine, indicating that for gelatinase activity the SH group is not necessary.

Further experiments with sand cultures of soya bean, pea and broad bean carried out by Dr. G. Bond fail to confirm appreciable excretion of nitrogenous substances from these root nodules.

Research Items

Standards of Living in Africa

THE problem of raising the standard of living in native Africa, with special reference to the contribution to its solution which may be made by the anthropologist, has been the subject of consideration by Dr. Margaret Read in the light of recent experience among the Ngoni of Nyasaland (International Institute of African Languages and Cultures, *Mem.* 16; 1938. Oxford University Press. Pp. 56. Price 1*s*.). Apart from the difficulty of a quantitative evaluation of the present standard of living in a community existing partly on a subsistence economy, partly on a money economy, the problem of raising the standard calls for a deeper analysis, probing to the values which govern present consumption and the incentives which determine present production—in other words, study of 'institutions'. Study of Ngoni institutions shows that in the past economic activities were dependent upon, and organized through, the social system of the people. In the changes due to cultural contact it is the economic life which has been altered most radically. The native authorities, though deprived of most of their traditional means of wealth, are expected to promote schemes of native welfare more or less on European lines. The fundamental difficulty is that economic progress cannot be dissociated from political and social development, if either are to be maintained. In a brief survey of cattle keeping, agriculture and the paramount chief's market, it is shown that there is no automatic reaction to environment, nor is there any automatic or uniform reaction to culture change introduced by Europeans. The Ngoni have resisted the suggestion of a 'commercial attitude' towards cattle. Their organization of agriculture and distribution of its proceeds have collapsed, owing chiefly to forces outside their control; but in the paramount chief's market he has created deliberately a new form of activity, which though based on an old traditional relationship, meets some of the new needs of the people. The variation in the reactions of the people to efforts to improve their welfare suggests the usefulness of careful preliminary inquiry before introducing innovations such as farm schools and co-operative societies. Economic progress must be in line with political development if either are to achieve stability and permanence.

Manuring of Soft Fruits

Two interesting investigations on the manuring of soft fruits have recently been recorded (*J. Pom. and Hort. Sci.*, **16**; 1938). The first, by T. Wallace, concerns black currants, and the second, by T. Wallace and V. G. Vaidya, refers to strawberries. The black currants, variety Baldwin, were given a series of manurial treatments consisting of farmyard manure, no manure, complete artificials, and complete artificials less nitrogen, phosphorus and potassium respectively. The order of crop yields was the same as that for vigour, namely, farmyard manure, complete artificials, omit nitrogen, omit phosphorus, omit potassium. Severe attacks of *Pseudopeziza Ribis* occurred each year; potash deficiency appears to have decreased susceptibility to this fungus, whilst deficiencies of nitrogen and potassium tended to increase it. The strawberries, variety Royal Sovereign, were given three dung treatments, complete organic manures containing shoddy and dried blood respectively as sources of nitrogen, dried blood without potash, complete artificials, and no manure. Dung produced greatest vigour though the results from shoddy and complete artificials were similar. Dried blood manure with and without potash gave relatively poor vigour and the yields from these plots were low. Evidently dried blood is a poor source of nitrogen for strawberries. The largest yields occurred on the dung plots. Manuring did not affect the ripening season, the proportions of marketable fruit in the crop, or the incidence of pests and diseases.

Seasonal Transmission of Cassava Mosaic

A SHORT paper by Dr. H. H. Storey and R. F. W. Nichols (*East African Agri. J.*, **3**, No. 6, 446–449; May 1938) describes a field experiment upon the transmission of cassava mosaic, a virus disease. Infection experiments were repeated at continuous monthly intervals for two years, and it is thereby established that virus transmission is greatest from February to May, and least from August to October, in East Africa. This would doubtless have some relation with the insect population of the area; but the practical result emerges that planting of cassava in June is most beneficial, since the main period of growth is made when virus transmission is at a minimum.

Separation of Mixtures of Gases and Isotopes

A NEW method for the separation of mixtures of gases, which can be applied to the separation of mixtures of gaseous isotopes, is described by K. Clusius and G. Dickel (*Naturwiss.*, **26**, 546; 1938). A vertical hot surface (an electrically heated wire was used) is placed opposite a cold surface. The gas mixture is between the two. The various processes of thermal diffusion and convection result in a concentration of the heavier component of the mixture at the bottom of the apparatus, and of the lighter one at the top. Using an apparatus 65 cm. long and a temperature difference between the surfaces of 300°, a mixture containing 25 per cent bromine and 75 per cent helium was completely separated. With an apparatus 1 metre long and a temperature difference of 600°, pure carbon dioxide was obtained from a mixture of 40 per cent carbon dioxide and 60 per cent hydrogen. With normal neon in an apparatus 2·6 metres long and a temperature difference of 600°, the proportion of isotopes in the gas drawn off at the bottom of the apparatus was ^{20}Ne 68·4 per cent, ^{21}Ne 0·6 per cent, ^{22}Ne 31·0 per cent, whereas normal neon contains ^{20}Ne 90·0 per cent, ^{21}Ne 0·3 per cent, ^{22}Ne 9·7 per cent. When normal hydrogen chloride containing 23 per cent H^{37}Cl and 77 per cent H^{35}Cl was used, the concentration of H^{37}Cl in the gas obtained at the base of the apparatus was increased to 40 per cent. The atomic weight of the chlorine in this mixture is 35·56, 0·10 units greater than the international value of 35·457.

Protection of Telephone Circuits

To the *Strowger Journal* of July published by the Automatic Telephone and Electric Co., Ltd., of Liverpool, Mr. T. B. D. Terroni communicates an instructive paper on the protection of telephone circuits from inductive interference. He first refers to the excessive voltages which occur on telephone lines due to faults on power transmission lines. These induced voltages are sometimes of sufficient magnitude to be a danger to telephone employees and to cause great damage to telephone apparatus. This type of problem occurs on railway systems where privately owned telephone lines run parallel to the track close to the main high-tension distribution network. The telephone lines are used for telephony, signalling and the remote control of sub-stations from a main control station. The danger can be obviated by means of a large inductive coil, called a drainage coil, connected between the two wires of a telephone line, with its mid-point in contact with the earth. A further source of disturbance arises from the fluctuations of the earth potentials, near a power station, when an earth fault occurs. The fault acts as a source of power and the station earth acts as a sink, so that currents flow through the earth. The potential of the earth in the vicinity of the power station may be so high as 3,000 volts above the earth potential at some distance away. When British P.O. lines are hired to operate between 132 kv. grid sub-stations and a central indicating station, trouble is obviated by terminating all the P.O. circuits in special isolating transformers. Cable circuits are much more immune from lightning induction trouble than overhead lines. In desert areas, open wire lines are known to experience high voltages as the result of sand storms. The voltages appearing in the telephone loop are probably due to the charging up of the two conductors by the highly charged particles of sand. The use of neon arresters to discharge these potentials to earth give rise to acoustic shock in the telephone receiver. This is due to the repeated discharges of the lines to earth through the neon tubes, which do not necessarily flash simultaneously. This is remedied by using the new 'atmite' protectors.

Atomic Weight of Carbon

E. Moles and A. Escribano have recently redetermined the atomic weight of carbon (*Comptes rendus*, **207**, 66; 1938). The method involved the determination of the limiting densities of carbon dioxide and oxygen, this being carried out by adsorbing known volumes of the gases on charcoal at the temperature of liquid air, the charcoal being weighed before and after the adsorption. The determinations were made at 760 mm. and 380 mm. pressure, and the limiting density was obtained by extrapolating to zero pressure, assuming the variation to be linear. The values obtained for the limiting densities were: oxygen, 1·427644 gm. per litre; carbon dioxide, 1·963340 gm. per litre. This gives 44·0074 for the molecular weight of carbon dioxide, and 12·0074 for the atomic weight of carbon. This is almost identical with the value obtained by Moles and Salazar in 1934 from the ratio $CO : O_2$, but differs slightly from the value (12·010) accepted by the Committee on Atomic Weights of the International Union of Chemistry, the eighth report of which is just published (*J. Chem. Soc.*, 1101; 1938).

New Transformation Product in the Trans-Uranium Series

PREVIOUS work has shown that the irradiation of uranium with neutrons gives rise to three transformation series, the first two of which have been followed as far as eka-platinum (atomic number 96) and eka-osmium (atomic number 94) respectively, whilst the nature of their emitted radiation makes it possible to assume that eka-gold (atomic number 97) and eka-iridium (atomic number 95) respectively are further produced. In the third series a β-radiating uranium of half-life 23 min. only has been detected, which possibly gives rise to eka-rhenium. The three series may be summarized as follows: (1) $^{92}U + n \rightarrow (^{92}U + n)$

$$\xrightarrow[10\ \text{sec.}]{\beta} {}^{93}\text{eka-Re} \xrightarrow[2{\cdot}2\ \text{min.}]{\beta} {}^{94}\text{eka-Os} \xrightarrow[59\ \text{min.}]{\beta} {}^{95}\text{eka-Ir} \xrightarrow[66\ \text{hr.}]{\beta} {}^{96}\text{eka-Pt} \xrightarrow[2{\cdot}5\ \text{hr.}]{\beta} {}^{97}\text{eka-Au ?}$$

; (2) $^{92}U + n \rightarrow (^{92}U + n)$

$$\xrightarrow[40\ \text{sec.}]{\beta} {}^{93}\text{eka-Re} \xrightarrow[16\ \text{min.}]{\beta} {}^{94}\text{eka-Os} \xrightarrow[5{\cdot}6\ \text{hr.}]{\beta} {}^{95}\text{eka-Ir ?}$$

; (3) $^{92}U + n \rightarrow (^{92}U + n) \xrightarrow[23\ \text{min.}]{\beta} {}^{93}\text{eka-Re ?}$ The transformation products in the first two series are isomeric nuclei, those in the second series being always of longer half-life than in the first. This led Hahn, Meitner, and Strassmann (*Naturwiss.*, **26**, 475; 1938) to look for an activity of eka-iridium in the second series of long half-life, since the eka-iridium of the first series has a half-life of 66 hr. By irradiating 10–20 gm. of uranium for some months with neutrons within paraffin, and examining the products, the existence of a new transformation product with a half-life of about 60 days was indicated. The genetic position of this product is still uncertain, but it would appear to be the eka-iridium of the second series that was sought.

Evolution of Eclipsing Binaries

DR. ZDENĚK KOPAL has recently published a paper (*Mon. Not. Roy. Astro. Soc.*, **98**, 8; June 1938) in which he examines the fission theory of the origin of binaries and also the question of an evolutionary progression or of a statical interpretation as suggested by their physical properties. It is well known that the ratio r_1/r_2, where r_1 and r_2 denote the radii of the primary and secondary, respectively, decreases with an increase in the separation of the components. Thus in the closest systems the primary is much larger than the secondary, the reverse being true in the widest systems, and the present separation is a rough criterion of the stage of evolution, provided the components were originally in contact. A difficulty arises here. The total angular momentum of the system resides chiefly in the orbital momentum, and as separation can be effected only by internal action, such as tidal friction, there is little scope for such taking place at the expense of the rotational momenta of the constituent stars. It appears that the eclipsing systems must have larger stores of angular momenta in the rotation of their components than can be obtained on the assumption that they rotate as rigid bodies with constant Keplerian angular velocities. It is suggested that the interior may rotate more rapidly than the surface layers. If this took place, so that rotational and orbital momenta are comparable, observational facts are not essentially incompatible with the fission theory.

Sixteenth International Physiological Congress

FOUR successive international congresses, on cytology, physiology, veterinary science and history, respectively, have been held in Zurich this year. Each physiologist who had given his address, found in his room a packet containing a badge with his name on it, a list of members with local and home addresses, a small book dealing with the life and work of Albrecht von Haller, a copy of a special number of the *Schweizer Medizinischer Wochenschrift*, a book of abstracts of communications (if this had not been sent in advance), a history of the congresses, and travel folders about Switzerland and Zurich.

The Congress met without any formalities in the hall of the University on the evening of August 14. The president, Prof. W. R. Hess, opened the congress next morning in the 'Auditorium Maximum' of the Technische Hochschule. After welcoming the members of the Congress, he thanked Dr. K. J. Franklin and the Physiological Society of Great Britain and Ireland for making it possible to distribute the "Short History of the International Congresses of Physiologists" to all those present, and said that he thought that this would be of great value in fixing the tradition of these congresses (cf. NATURE, July 30, p. 222). This year marked the truly physiological hemicentenary of the first Congress, which was conceived in 1888 and met a year later, and the president expressed the gratitude of those present to the founders. Five survivors of the first congress were present, and telegrams of greetings and gratitude were approved by the meeting and dispatched forthwith to others who could not come. The meeting stood in silence to express its sorrow for the loss of those physiologists who had died in recent years, with particular mention of Pavlov, Johansson, Fredericq, Haldane, Cremer, Macleod and Abel. The president hoped that the present Congress would be worthy of the high ideals of its early predecessors.

The rector of the University of Zurich, Prof. E. Howald, welcomed the Congress in German on behalf of all the seven Swiss universities, and added that he was happy to be able to say that, in this particular matter, the universities were unanimous. The Congress was also welcomed in two other official Swiss languages—French and Italian.

Prof. L. Lapicque spoke in honour of the jubilee as a member of the first Congress. He was glad to see so many young people carrying on the work of physiology, and happy to think that once this work had been published and distributed to the libraries of the world it would live, although more concrete things might be destroyed. Since the last congress, the political situation had become less stable, and the Congress was fortunate in meeting in a country that was famous for its international atmosphere.

Sir Henry Dale spoke on behalf of all in English, which experience had taught him to be one of the unofficial languages of Switzerland. He thanked the president, and those others who had spoken in welcome. He thanked Prof. E. Rothlin, and those others who had organized the Congress. They had done much to re-establish the early traditions of friendly informality described by Dr. Franklin. Physiological congresses should not be associated with formal official receptions, and members should represent nothing but devotion to physiology and friendship for other physiologists. Switzerland had been proposed as a place for the first Congress because it was central, hospitable and attractive. The sixteenth Congress was glad to be able to meet in Switzerland not only for these reasons, but also because of the great scientific achievements of Swiss physiologists.

The scientific meetings started on Monday afternoon, and continued each morning and afternoon until Friday, with a break on Wednesday afternoon, which was devoted to an expedition on the Zürichsee to Rapperswil. Meetings were held simultaneously in five large lecture rooms in the Technische Hochschule, which is extraordinarily well adapted for the holding of congresses. The afternoons were mostly devoted to arranged discussions on chosen subjects—an innovation which was generally considered a great success. Each discussion was opened by two chosen speakers, and an abstract of their contributions was circulated some weeks in advance. They were followed by other speakers, most of whose contributions were also abstracted in a second volume circulated just before the Congress. At intervals the discussion became general, and arrangements were made by which it was possible for the chairman to invite particularly obstinate disputants to withdraw to another room so that the meeting might continue. There were also in the original programme about 330 individual communications, summaries of most of which were contained in the second volume of abstracts. These were grouped according to subject, and the discussions which arose were sometimes as interesting as the arranged discussions, and were continued in neighbouring cafés or in the *Studentenheim*, where meals were provided for the members of the Congress.

There were about fifty demonstrations, half of which were permanently on view, and the other half were each shown twice. The programme also contained twenty-seven films, some of them coloured, which were each to be shown twice between 5 and 6.15 p.m. on different days.

It is difficult to give an account of the scientific results announced at such a congress. The book of abstracts gives an interesting cross-section of the physiological thought of the day, but it takes some time to read it all, and there are probably few who could criticize it all. Papers which sound very good in abstract often sound less good when they have been criticized in the meetings. No one person could attend more than about a fifth of the meetings, and it is difficult even to be certain which papers have actually been delivered. The following papers, however, deserve special mention for various reasons.

Prof. W. R. Hess demonstrated ingenious and interesting methods for stimulating or destroying subcortical areas of the brain and observing the results. H. Theorell advanced a formula for the prosthetic group in cytochrome *c*. V. Menkin described the isolation from inflammatory exudates of a crystalline polypeptide 'leukotaxine', which increases permeability and attracts leucocytes. W. Feldberg and C. H. Kellaway presented evidence that the response of cells to injury is partly due to

the liberation of lysocithin. R. J. Williams described the isolation and properties of pantothenic acid—a universal growth stimulant present in all cells. J. F. Toennies presented evidence that sensory stimulation may evoke a reflex which leads to the appearance of antidromic inpulses in dorsal spinal roots. A. v. Muralt demonstrated an apparatus which plunges nerve trunks into liquid air while impulses are actually passing, so that various evanescent effects of the impulses can be detected. F. Schütz demonstrated an apparatus for studying adsorption on foam, which may be useful in separating substances of physiological importance. J. S. Fruton described the results of the study of the action of various proteinases on simple peptides, which show that they may act specifically on the link between one particular pair of amino acids. A. C. Ivy demonstrated the masculinization of female rat embryos by the injection of male hormone into the mother during pregnancy, and also the reverse effect on male embryos. Another demonstration showed the same effect as the result of the injection of the embryos themselves by laparotomy. E. H. Venning and J. S. L. Browne described the results of a study of the physiology of progesterone by estimating its excretion product in the urine. R. D. Wright and H. W. Florey described interesting experiments on the secretion of the colon. L. A. Maynard, C. M. McCay and G. Sperling demonstrated experiments in which rats lived longer than normal rats and retained their youthful appearance, when they were fed on a diet which was deficient in calories, but otherwise complete.

The most popular discussions were on urinary excretion, the chemical transmission of nervous impulses, steroids, the adrenal cortex and the hypophysis. It was unfortunate that the last two of these discussions were held simultaneously.

The pharmacologists held a special meeting at which they discussed the scope and future of their science. Sir Henry Dale accused them of not taking an active interest in the important new remedies which are being introduced so rapidly, and of leaving the practical application of hormones, vitamins and chemotherapeutic agents to physiologists, biochemists and pathologists, who often have no medical training. Various speakers replied that pharmacological teaching does in fact keep up to date, and that pharmacological research is more likely to be fruitful if pharmacologists are allowed to study what interests them, than if they are diverted to the study of the practical applications of the work of others. Pharmacology has been handicapped because it has been regarded as a handmaid of medicine. Its proper scope includes not only the study of the scientific basis of therapeutics, but also more general problems of how drugs act, methods of assay and standardization, the absorption and fate of drugs, factors determining the intensity of their action and their toxic effects not only on man, but also on other forms of life such as insects, weeds, worms, protozoa, and bacteria. The pharmacologist must know something of many sciences, but diversity of interests has been stimulating in the past and is likely to be so in the future.

On Thursday evening the members of the Congress were divided into groups with common interests, and entertained to dinner in various parts of Zurich. Interesting speeches of welcome and of gratitude were made and there were various other postprandial entertainments.

The final meeting was held on Friday afternoon. Prof. A. V. Hill presented the report of the permanent International Committee. Prof. L. A. Orbeli was elected to succeed Pavlov on this committee and there was some general discussion of procedure. Sir Henry Dale, on behalf of the Physiological Society, invited the Congress to meet in England in 1941 and this invitation was accepted. Prof. Houssay put forward an invitation to Buenos Aires in 1944, which was received with enthusiasm.

The Swiss committee is to be warmly congratulated on the arrangements for this Congress, which were simple and worked smoothly and without delay. Membership was limited to genuine physiologists approved as such by national committees, so that the temporary physiologists who have attended some recent congresses were excluded, but this arrangement is unfortunately open to abuse, since it makes it possible for genuine physiologists to be excluded for political reasons. About 1,100 members registered, and they were officially accompanied by 260 other persons. There were no Russians, but most other nations were well represented. A number of Spaniards, including Prof. Negrin, were able to come.

J. H. GADDUM.

Twelfth International Horticultural Congress

THE formal opening of the Twelfth International Horticultural Congress took place at 11 a.m. on August 12 in the Plenary Hall of the Congress Building (Kroll Opera House), Berlin, when the president, Herr R. Walther Darré, Reich Minister for Food and Agriculture and Reich Peasant Leader, gave a speech of warm welcome to all members, who represented about fifty nations. Addresses were also delivered by Herr Johannes Boettner, managing president; Prof. F. Angelini, first vice-president of the Congress; and Dr. J. J. L. van Rijn, vice-president of the International Institute for Agriculture, Rome. The British delegation was headed by Dr. H. V. Taylor, of the Ministry of Agriculture, and included Sir Arthur Hill, Sir Frank Stockdale, Colonel F. R. Durham, R. G. Hatton (East Malling), F. J. Chittenden and Dr. M. A. H. Tincker (Wisley).

In view of the numerous and varied horticultural problems to be discussed during the week, twenty sections were set up embracing all branches of horticulture, such as growing of fruits and vegetables, nurseries, nomenclature, park and garden planning, education, physiology, etc. As it was quite impossible to attend all the sectional meetings, the present account cannot claim to be complete, and mention can be made only of the few sections visited. In the Section of Education great interest was shown in the international exchange of young gardeners. M. Tubart outlined the existing position and made proposals for the further extension of the system. In

the general discussion that followed, Sir Arthur Hill gave an account of the system of exchanges in operation at Kew. The first exchange was with Italy fifteen years ago and exchanges have since been made with Germany, France, Belgium, Holland, Denmark, Norway, Sweden, United States, Canada, South Africa, Australia and New Zealand.

In the Section of Nomenclature, under the chairmanship of Dozent A. Thorsrud, of Norway, it was obvious that there was a real desire to arrive at practical rules for the horticulturists, and there seemed to be very general agreement. Unlike the proceedings at the International Botanical Congresses, however, the voting on the nomenclature proposals is restricted to the members of the Permanent Committee in closed session. There was a very general feeling that some standard list of names of horticultural plants should be published, and Miss M. L. Green (Kew) gave an account of the work of the Special Committee on the Correct Names of Economic Plants (including Horticultural Plants), appointed at the International Botanical Congress, Amsterdam, 1935. This Committee will publish a list of the correct names of economic plants in accordance with the International Rules, which list will remain in force for ten years even if any of those names are in the meantime found to be not in accordance with the Rules. This will be an important factor in stabilising plant nomenclature.

On Monday, August 15, Colonel F. R. Durham, secretary of the Royal Horticultural Society, gave a special report on the object and purpose of exhibitions and trials of new varieties in regard to the advancement of horticultural breeding, and showed what a stimulating effect exhibitions and trials upon plant breeding have on modern horticulture.

In addition to the more serious work of the Congress, a very varied programme of excursions and entertainments was arranged and, as the large attendances showed, was much appreciated by the members. Visits were paid to various biological institutions such as the Reich Biological Institute for Agriculture and Forestry, the Experiment and Research Institute for Horticulture, and the Botanic Garden, Dahlem. Botanists attending the Congress were very glad to have the pleasure of renewing their associations with the Dahlem Herbarium and Gardens, where they were given a hearty welcome by the director, Prof. L. Diels, and his staff. Many motor-coach trips were arranged, and visits were paid to well-known nurseries such as that of Herr L. Späth at Retzin and of Herr K. Förster at Bornim.

Another feature of special interest was the exhibition entitled "500 years of German Gardening" organized by the Reich Ministry of Food and Agriculture. This was held in the Prussian State Library and illustrated the history of German garden flowers, fruits and vegetables, and the development of the style of German gardens from 1400 to 1900. Interesting illustrations from ancient books, manuscripts and prints were on view, also drawings, engravings and oil paintings. The whole exhibit was extremely well planned and repaid careful study.

No account of the Congress would be complete without a word of admiration for the decorations at the Congress Buildings—there was a wealth of beautiful flowers to be seen everywhere. The names of the various halls were indications of the decorations within, such as the Tropical Hall, the Rose Hall, the Larkspur Hall, and the Fruit Hall. The thanks and congratulations of all members are due to the organizers of this very successful congress.

Institution of Gas Engineers

THE seventy-fifth annual meeting of the Institution of Gas Engineers was held in London on May 31–June 3 when Sir David Milne Watson received the Birmingham Medal in recognition of his encouragement of research bearing on the manufacture and utilization of gas*. In his presidential address, Mr. H. C. Smith, of Tottenham, stated that the gas industry is under statutory obligation, subject to penalties, to supply gas of declared calorific value, prescribed purity and minimum pressure, whereas those who sell its raw material—coal—are encouraged by statute to raise the price of coal without any obligation as to its quality. He said that more than one million tons of useless material, which might have been removed from the coal at the collieries, had in 1937 been delivered to the gas works, to the detriment of both the carbonizer and the user of coke. He suggested that legislation concerning the coal industry should not stop at machinery for raising prices, but should impose obligations to supply coal of prescribed and regular quality.

Mr. E. V. Evans, discussing the processing of coal, said that the gas industry might be at the start of a new and greater era. The industry carbonizes coal primarily for the production of gas, and the by-products —especially coke—are subsidized at the expense of the gas. For this reason, together with legal restrictions, the gas must be sold at prices which make it a luxury fuel. Before it can take its place as a staple fuel, gas must be freed from this burden, as is the case where it is a by-product of the manufacture of metallurgical coke. The ideal, it has long been recognized, would be to convert coal into a gaseous fuel of high calorific value. Experience where natural gas and cheap coke oven gas are available shows that the advantages of such a fuel lead to an enormous expansion in its use. During the last three years, the Joint Research Committee of the Institution of Gas Engineers and the University of Leeds has been examining the gasification of coal under pressure. It has been established that coal can be hydrogenated to yield gas and some liquid fuel without combustible residue under quite moderate pressures such as are current in steam boiler practice. The results leave no doubt that the complete gasification of the ash-free coal to form a high-grade gas is technically feasible and it remains to establish its economic future.

A paper by Dr. F. J. Eaton on the uses of coke revealed the rapid expansion in the consumption of gas coke since scientific study had shown what merits were to be found in this somewhat neglected smokeless fuel and how they could be turned to advantage.

H. J. H.

* Institution of Gas Engineers. 75th Annual General Meeting, London, 31st May to 3rd June 1938. No. 177. Official Programme. Pp. 16. No. 178. Annual Reports and Accounts of the Council of the Institution of Gas Engineers. Pp. 44. No. 179. Presidential Address. By H. C. Smith. Pp. 24. No. 180. Considerations upon the Processing of Coal. By E. V. Evans. Pp. 40. (Institution of Gas Engineers.) 2s.

Royal Photographic Society's Annual Exhibition

THE eighty-third annual exhibition of the Royal Photographic Society at 35 Russell Square, London, will remain open until October 8.

Several photographs are shown of the tracks formed by elementary particles ejected by disrupting atoms embedded in the emulsion. The spacing of the grains in a track is characteristic of the particle and its energy. Among the examples shown are the tracks of α-particles ejected by cosmic rays and neutrons, the α-particles from thorium C′ and tracks due to protons and deuterons. Another interesting photograph shows the identification of the radio-active isotope of samarium from the direct deposits of the isotopes by a mass-spectrograph on the photographic emulsion. Short tracks are to be seen under the isotope of mass 148.

The recent theory of latent image formation by Gurney and Mott is illustrated by a series of diagrams representing the electronic and ionic processes involved. Of particular interest is the photograph showing the destruction by red light of the unformed latent image at low temperatures, thus demonstrating the existence of trapped electrons.

A series of ripple tank photographs illustrates the diffraction and interference effects of waves, and some direct photographs of optical interference fringes are designed to show the variation of fringe width with colour. Two photographs demonstrate a method of estimating the amount of odoriferous vapour given off by a flower by comparing its action with that of camphor vapour on the appearance of a talc-covered pool of mercury as a monomolecular layer of the vapour forms on its surface.

One of the most interesting exhibits is a 15-ft. solar spectrum taken on Kodachrome film at the Mount Wilson Observatory. Other astronomical exhibits include photographs of the sun's corona and prominences taken during the total eclipse of June 8, 1937. A number of very fine cloud photographs show the formation of thunderclouds and the appearance of a line squall.

The use of photography in aerial survey is illustrated by photographs taken with a nine-lens air camera which covers up to 300 square miles at one exposure. Another aerial photograph shows the presence of archæological remains by faint markings in the soil which may be quite indistinguishable to an observer on the ground. Some high-speed photographs are on view, one of a revolver firing taken at an exposure of two millionths of a second.

A series of twenty-two wedge spectrograms exhibited by Ilford Limited show that it is possible to sensitize emulsions in any selected region over a considerable range of the spectrum. Kodak Limited have an interesting exhibit showing the image of a spectrum on Kodachrome film at each stage of the processing. Another exhibit shows the technical basis of the Kodak wash-off relief colour printing process.

The exhibition also includes a number of photomicrographs of biological, botanical and metallurgical subjects, and others demonstrating the value of photomicrography in the detection of forgeries and other criminal investigations. The radiographs cover a wide range of subject types, but there is an unfortunate lack of technical data. New photographic apparatus is on view in various parts of the exhibition.

Decapod Larvæ of the Great Barrier Reef*

DR. GURNEY describes some very interesting larvæ in his latest work. The life-histories of the Palæmonidæ are little known except for certain members of the Palæmoninæ, and a large series of larvæ from the Great Barrier Reef together with material from Ghardaqa on the Red Sea and from the "Discovery" Expedition has enabled the author to make a decided increase in our knowledge of the group, which is a difficult one.

Among the Palæmonids are specimens belonging to Ortmann's larval genus *Retrocaris*, of very large size, and the study of these leads to the conclusion that the larvæ of the *Retrocaris* group belong to the genus *Palaemon* or the closely related *Brachycarpus*, which, although the adults inhabit fresh water, may in certain species migrate to the sea to liberate their larvæ. A summary is given of the characters of the last larvæ of *Leander* (excluding *L. tenuicornis*, which differs conspicuously and should possibly be placed in a separate genus) and of *Retrocaris* (*Palaemon* or *Brachycarpus*). The larval Pontoniinæ in the collections belong to two groups, one of which, the Periclimenes group, is easily defined and a fair amount is known about them. It is exceedingly interesting, however, that the larvæ of *Periclimenes diversipes* and *Harpilius gerlachei* indicate quite a different generic grouping of the adults from that which is adopted by Kemp. A study of the adults apparently bears this out, *P. diversipes* differing from *Periclimenes grandis*, *P. agag* and *P. americanus* in almost every appendage and resembling *Harpilius* or *Coralliocaris*. Larvæ of the Mesocaris group of the Pontoniinæ are much more difficult to classify. The new name *Cryptoleander* has been coined for a third group including three peculiar larvæ. *Anchistoides* also has very distinct features, and the late larvæ almost certainly belonging to this genus are most striking. It is suggested that it should not be placed in the Pontoniinæ but in a distinct sub-family.

The Alpheidæ show as a rule great uniformity of structure in the larvæ, several of which are described. Their main interest lies in the apparently close relationship with the Palæmonidæ. Hitherto there has been a tendency to regard this family as more nearly related to the Hippolytidæ, but the discussion at the end of this paper shows that the Alpheid and Palæmonid larvæ agree in many characters, well shown in the present material. The fact that a species of *Coralliocaris* was found which snapped its claws like an Alpheid is significant.

* The Larvæ of the Decapod Crustacea. Palæmonidæ and Alpheidæ. By Dr. Robert Gurney. (Great Barrier Reef Expedition 1928-29. Scientific Reports, 6, No. 1). (London: British Museum (Natural History), 1938).

Science News a Century Ago

London and Birmingham Railway

THE most important event in railway history in 1838 was the opening on September 17, 1838, of the whole length of line, 112½ miles long, from London to Birmingham. Parts of the line had been in use for some time, but at 7 a.m. on that day a train left Euston carrying the directors, the principal engineers and a few friends, Robert Stephenson, the engineer-in-chief, being in charge of the locomotive. The new portion opened on September 17 was that between Denbigh Hall and Rugby, on which is situated the Kilsby Tunnel, 2,400 yards long, which had proved most difficult to construct. Describing the opening, a correspondent of *The Times* said, "Taking this line of road as a whole, it is one of the most stupendous undertakings of modern times, and will ultimately lead to results of which it is difficult to foretell the extent."

J. D. Forbes and His Students

FORBES, when professor of natural philosophy at Edinburgh, had among his students during the session 1836–37, "Batten, Cleghorn, J. Anderson, J. Rankine, Harrison—the pleasantest I ever had, much occupied with experiments on radiant heat". He kept in touch with some of these and writing on September 17, 1838, to J. T. Harrison, who became a civil engineer under Brunel, he said: "There has been a considerable break up, of course, among your associates in the Nat. Phil. Class. Still, however, I have kept my eye pretty well upon those with whom you were more particularly associated and the Physico-Mathematical Society prospered last winter remarkably well. . . .

"I shall be glad to hear, though I scarcely expect it, that you have not in the midst of your professional pursuits entirely lost sight of the general scientific principles which form its surest foundation. I do not doubt your good-will or the clearness of your views of what befits a liberal and enlightened prosecution of your profession. That I am sure you will never do; but I rather fear that the very success to which your talents and application so well entitle you, may have already forced you to travel upon the narrow railroad of everyday applications. . . ."

The Duke of Sussex and the Royal Society

IN 1830 Prince Frederick Augustus, Duke of Sussex (1773–1843), had accepted the presidency of the Royal Society. He took office just after Babbage had published his "Reflections on the Decline of Science in England" and Sir James South had written his "Charges against the President and Council of the Royal Society". The Duke was elected by 119 votes as against 111 cast for Sir John Herschel. He held office for eight years, and when he decided to resign he wrote a letter to the Council which was published in the *Athenæum* for September 22, 1838. In the course of this letter he said: "I hope and most fervently pray that the Royal Society may long continue to prosper and flourish, but for this purpose, Gentlemen, you must avoid all matters which are of a tendency to create angry feelings, or heart burnings, on questions of a religious or a political nature. They have nothing to do with science but to create difficulties and impede philosophical researches. From these let me conjure you most cautiously to abstain."

Societies and Academies

Paris

Academy of Sciences (*C.R.*, **207**, 197–264, July 18, 1938).

E. BOREL: The game *pari mutuel*. A study from the point of view of probabilities.

L. CAYEUX: Existence of a coarse calcareous sand at the base of the Senonian phosphatic chalk of Picardy.

J. DE LAPPARENT and R. HOCART: Mineralogical nature of the aluminium hydroxides in the bauxite of French West Africa.

H. DELANGE: Series of polynomials of which the zeros have a regular distribution.

F. GANTMACHER: Canonical representation of isomorphic substitutions of a semi-simple complex Lie group.

A. DENJOY: Convergence of trigonometric series.

L. CHADENSON: A completely relativistic wave mechanics.

L. AUGER: Tuning reed pipes considered as a phenomenon of relaxation.

E. BADAREU and L. CONSTANTINESCO: The explosive potential in benzene vapour.

MME. I. MIHUL and C. MIHUL: Mixed reflection in media with variable optical indexes; application to the ionosphere.

M. DÉRIBÉRÉ: Highly persistent fluorescence in a group of natural limestones.

E. CANALS and P. PEYROT: Raman spectra of crystalline powders: hydrates.

J. THIBAUD and P. COMPARAT: Distribution of resonance levels during the excitation of nitrogen by fast neutrons.

P. AUGER and R. MAZE: Large atmospheric cosmic ray showers. Particles with a maximum range of 15 cm. of lead were detected.

B. PONTECORVO: Order of magnitude of the probabilities of radiative transition in the nucleus.

W. BRONIEWSKI, S. JELNICKI and M. SKWARA: Solidification diagram of copper-aluminium alloys.

G. CHAUDRON, A. PORTEVIN and L. MOREAU: Some consequences of the process of degassing metals at ordinary temperature.

A. CHRÉTIEN and J. BISCH: Active aluminium obtained by igneous electrolysis. A mixture of aluminium bromide and potassium bromide under pressure at 500°, using aluminium as anode and mercury as cathode, yields an active form of aluminium at the cathode.

P. GRAMMATICAKIS: Action of organomagnesium mixtures on the *N*-acyl-*N'*-phenyl-hydrazines.

R. JACQUEMAIN and MLLE. G. DEVILLERS: Some propanetriol aminobenzoic ethers.

L. MARTINEAU and J. WIEMANN: Isolation of an intermediate product in the catalytic isomerization of dipropenylglycol.

P. MARIE and A. MILLARDET: The microscopic fauna of the sediments of the Cape Breton deep.

T. SOLACOLU, D. CONSTANTINESCO and MME. M. CONSTANTINESCO: Anatomical and cytological study [in *Vicia Faba* L.] of the modifications produced and by a mixture of an organo-formative substance and colchicine. While colchicine produces nuclear effects only, a mixture of colchicine and β-indolyl-propionic acid produces tumours showing an upper zone with colchicine effects and a lower zone with exaggerated development of meristem.

MME. L. LAVIER-GEORGE: Floral anomalies of *Laburnum vulgare* Grieseb.

R.-G. WERNER: Bryology and phytogeography.

MME. S. BELLUC, J. CHAUSSIN, H. LAUGIER and MME. T. RANSON: Study of the influence of wine on the elimination of urine.

J. ROCHE, MLLE. A. FILIPPI and M. MOURGUE: General reactions of the skeleton following fracture of a bone. All bones of the skeleton show a big increase of phosphatasic activity after fracture of any one of them.

R. DULSICOUËT and R. HERPIN: Experimental researches on the bacterial membrane which develops on the paints of ships' bottoms: its role in corrosion.

R. HIRSCH: Therapeutic results obtained by the slow intravenous injection of acidified physiological sera (*p*H 4·5–5). Such sera are powerfully analgesic and also anti-hæmorrhagic.

M. LANGERON: Anopheles of the Grand Atlas and of the Moroccan Anti-Atlas.

Rome

National Academy of the Lincei (*Atti*, 27, 37–144; 1938).

E. BOMPIANI: Anholonomous varieties. Some general theorems (1). The V_3^2 varieties of the projective element S_2 (2).

F. SEVERI: Concerning the theory of equivalent series on reducible curves.

O. SCARPA and C. ROSSI: Volta effect in solid metallic alloys (2).

C. P. BOGDAN: Concerning a class of V_3 varieties which admit of an infinity of quasi-asymptotic surfaces depending on an arbitrary function.

N. CARTOVITCH: Effective calculation of the period of perturbed motion in a typical case of first approximation.

G. GHERARDELLI: An observation on equivalent series on a reducible algebraic curve.

I. POPA: Observations on the parabolic line of a surface.

G. COLONNETTI: The second principle of reciprocity and its applications to the calculation of permanent deformations (1).

L. SONA: Some rigid configurations of vortex filaments perpendicular to one plane (1).

O. ZANABONI: Relations between internal action and deformations in envelopes with double curvature.

P. GUARESCHI: (1) Compressibility coefficient of solids. (2) Coefficient of thermal conductivity of gases.

G. GIACOMELLO: Structure of choleic acids determined by means of Patterson's analysis.

R. SIGNORINI: The fold of the Lagoni and Libro Aperto mountains in the Modenese Apennines.

P. PRINCIPI: The origin of some white earths from the Valle del Nestore (Umbria).

G. NEGODI: Cariology of the genera *Aposeris* and *Hyoseris* (Compositæ-Cichorieæ tribus Cichorinæ).

A. CORRADETTI: Some phases of the schizogonic cycle of *Plasmodium gallinaceum* and of *Plasmodium cathemerium*.

E. FULCHIGNONI: Reflex experimental epilepsy excited by light stimuli.

G. MARTINO and E. FULCHIGNONI: Phenomenon of facilitation in reflex epilepsy caused by occipital strychninization under the action of conditioned light stimuli.

V. ZAGAMI: Action of the vagi in the metabolism of glycides. (1) Behaviour of hepatic, cardiac and muscular glycogen following bilateral vagotomy in pigeons.

Forthcoming Events

INTERNATIONAL FEDERATION FOR DOCUMENTATION, September 21–26.—Fourteenth Conference, to be held at Lady Margaret Hall, Oxford (Sept. 21–25) and Science Museum, London, S.W.7 (Sept. 26).

September 21.—Sir William Bragg, F.R.S.: "The Historical Papers at the Royal Institution" (Presidential Address).

ASSOCIATION OF SPECIAL LIBRARIES AND INFORMATION BUREAUX, September 23–26.—Fifteenth Annual Conference, to be held at Lady Margaret Hall, Oxford. Joint sessions with the International Federation for Documentation on September 24 and 25.

Sir William Beveridge: "The Use of Books in Social Science" (Presidential Address).

Appointments Vacant

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:

JUNIOR SCIENTIFIC OFFICER (PHYSICIST) at the Fuel Research Station, East Greenwich—The Establishment Officer, Department of Scientific and Industrial Research, 16 Old Queen Street, Westminster, London, S.W.1, by postcard quoting "J. 38/11" (September 20).

LECTURER in the DEPARTMENT OF MECHANICAL ENGINEERING, lecturer in BUILDING AND ALLIED SUBJECTS and lecturer in BUILDING SCIENCE in the Central Technical College, Suffolk Street, Birmingham, 1—The Principal (September 20).

LECTURER IN PHILOSOPHY in the United College, St. Andrews—The Secretary and Registrar (September 24).

A FIELD OFFICER and an ASSISTANT SOIL ANALYST under the Advisory Chemist, Department of Agriculture, University of Cambridge—The Secretary, School of Agriculture, Cambridge (September 24).

ASSISTANT ENGINEER in the Punjab Service of Engineers, Class II (Irrigation Branch)—The High Commissioner for India, General Department, India House, Aldwych, London, W.C.2, by postcard (September 26).

LECTURER IN CHEMISTRY in the Sir John Cass Technical Institute, Jewry Street, Aldgate, London, E.C.3—The Principal (September 28).

A POST (AERIAL GUNNERY) in the Directorate of Armament Development, Air Ministry Headquarters, London—The Under-Secretary of State, Air Ministry (S.2.D.), Adastral House, Kingsway, London, W.C.2, quoting ref. *B*.94 (September 30).

TECHNICAL OFFICERS (*B*.59, design, development and manufacture of high explosive; *B*.92, metals and stresses; *B*.91, electrical and hydraulic engineering) at Air Ministry Headquarters, London—The Under-Secretary of State, Air Ministry (S.2.D.), Adastral House, Kingsway, London, W.C.2, quoting appropriate reference number (September 30).

TECHNICAL OFFICERS (AIRCRAFT, *B*.70) and TECHNICAL OFFICERS (ENGINES, *B*.88) and ASSISTANTS II to these officers (*B*.89 and *B*.90), at Air Ministry Headquarters, London—The Under-Secretary of State, Air Ministry (S.2.D.), Adastral House, Kingsway, London, W.C.2, quoting appropriate reference (September 30).

ASSISTANT ENGINEER for the Drainage and Irrigation Department, Malaya (M/5765), and ASSISTANT ENGINEER for the Malayan Public Works Service (M/5731)—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting appropriate reference number.

CIVIL ENGINEER for service with the Sudan Irrigation Department—The Controller, Sudan Government London Office, Wellington House, Buckingham Gate, London, S.W.1, envelope marked "Engineer".

Reports and other Publications

(not included in the monthly Books Supplement)

Other Countries

Ministry of Agriculture, Egypt: Technical and Scientific Service. Bulletin No. 190: Watermelon Anthracnose. By Dr. Amin Fikry. Pp. ii+21+10 plates. (Cairo: Government Press.) P.T. 4. [298

Indian Forest Records (New Series). Silviculture, Vol. 3, No. 1: An Investigation into the Best Root Length of Stump to use when Stump Planting Teak (*Tectona grandis*) in Areas having a General West Coast Type of Climate. By A. L. Griffith. Pp. ii+16. (Delhi: Manager of Publications.) 8 annas; 10*d*. [298

Imperial College of Tropical Agriculture. Seventh Annual Report on Cacao Research, 1937. Pp. 51. (Trinidad: Government Printing Office.) 5*s*. [303

U.S. Department of the Interior: Office of Education. Bulletin, 1937, No. 19: CCC Camp Education; Guidance and Recreational Phases. By Howard W. Oxley. (Project in Research in Universities.) Pp. vi+23. (Washington, D.C.: Government Printing Office.) 10 cents. [19

Proceedings of the United States National Museum. Vol. 85, No. 3039: The Cuban Operculate Land Shells of the Subfamily Chondropominæ. By Carlos de la Torre and Paul Bartsch. Pp. 193–423+plates 7–39. (Washington, D.C.: Government Printing Office.) [19